THE NAUTILUS

THE PILSBRY QUARTERLY
DEVOTED TO THE INTERESTS
OF CONCHOLOGISTS

VOL. 76

JULY, 1962 to APRIL, 1963

EDITORS AND PUBLISHERS

HORACE BURRINGTON BAKER
Professor Emeritus of Zoology, University of Pennsylvania

CHARLES B. WURTZ
Consulting Biologists Inc., Bethlehem Pike, Spring House, Pa.

R. TUCKER ABBOTT
H. A. Pilsbry Chair of Malacology, Academy of Natural Sciences

MRS. HORACE B. BAKER

PHILADELPHIA, PENNSYLVANIA

PONY PRINTING, UPPER DARBY, PA.

CONTENTS

Names of new genera, species, etc. in *italics*

INDEX TO AUTHORS

THE NAUTILUS

Vol. 76 July, 1962 No. 1

MESOMPHIX VULGATUS AND ITS ALLIES

By LESLIE HUBRICHT

The examination of a large amount of anatomical material of *Mesomphix vulgatus* and the species of *Mesomphix,* sensu stricto, closely related to it, has shown that these species cannot be distinguished by the shells with any degree of certainty. However, there are very good specific differences in the genitalia. In order to place the identification of the species of this group on a more secure basis, the author has prepared descriptions of the genitalia of all the species which were not described adequately by Pilsbry (Land Moll. N. Amer. II, pp. 319-317, figs. 162, 164.), as well as those of two new species. The distributions given are based on anatomical identifications.

MESOMPHIX VULGATUS H. B. Baker Plate 1, A; fig. 1, A.

Shell depressed with low spire, buffy-olive above, ecru-olive below, dull, opaque. Whorls about 5, rapidly increasing, well rounded, sutures moderately impressed. Embryonic whorls with fine radial striae, becoming stronger on later whorls, upper surface of last whorl with distinct radial striae which continue onto the sides, becoming obsolete on the lower surface. Upper and lower surfaces of last whorl covered with close, minutely papillose, spiral threads. Umbilicus very small, sealed with hardened slime. Aperture a little wider than high, lunate, with a white lining. Peristome somewhat oblique, sharp, slightly reflected over the umbilicus.

Height 11.9 mm. Diameter 21.0 mm. Spire width 11.0 mm. Aperture width 11.0 mm. Aperture height 9.6 mm. Topotype.

Penis rather short, club shaped, without an appendix, of uniform texture throughout its length. Interior of penis with two pilasters which extend the entire length of the penis. Penial retractor muscle short wide and thick, attached at the end of the penis. Epiphallus rather stout with an enlargement in the lower third, about three times as long as the penis, entering the penis near the middle. Spermatheca large, a flattened sphere or ovoid, duct short. Free oviduct about four times as long as the penis. Vagina about a third as long as the penis. Atrium very short, only reaching through the integument. In some

specimens there is a yellow glandular ring around the base of the vagina.

Penis 7 mm. Epiphallus 21 mm. Vagina 2.5 mm. Spermatheca duct 4 mm. Free oviduct 27 mm. Topotype.

Distribution.—*Indiana:* Harrison Co.: 0.5 mile northeast of White Cloud. *Kentucky:* Meade Co.: Ohio River bluff, 5 miles east of Brandenburg. Anderson Co.: Kentucky River bluff, just north of Tyrone. Mercer Co.: Kentucky River bluff, near Brooklyn Bridge. Jessamine Co.: cedar woods, Camp Nelson. Lincoln Co.: hillside, 5 miles south of Stanford. Edmonson Co.: near Mammoth Dome Sink, near Mammoth Cave, Mammoth Cave National Park (Plate , A). Warren Co.: Barren River bluff, at Ky.-101, south of Three Forks. Metcalfe Co.: ravine, near Piercy Cave, 2.5 miles south of Summer Shade; low woods, 1 mile west of Beaumont. Cumberland Co.: hillside, 1 mile northeast of Dubre; Cumberland River bluff, 1.8 miles southeast of Burksville. *Tennessee:* Sumner Co.: near creek, 1.5 miles north of Bransford; hillside, 1.7 miles south of Bransford. Macon Co.: ravine, 5 miles southeast of Lafayette.

Mesomphix vulgatus is found to be a species of rather limited range. The above localities are only those for which anatomical material was available. The real range is probably a little greater, particularly on the northern and western sides. It probably extends into southwestern Ohio and southeastern Illinois.

Mesomphix vulgatus is based on a shell collected in Kentucky by Rafinesque. The type locality is here restricted to the vicinity of Mammoth Cave, Edmonson Co., Kentucky, a locality which Rafinesque is known to have visited.

MESOMPHIX ANURUS, new species. Pl. 1 C; fig. 1, E.

Shell depressed with low spire, pale brownish-yellow, glossy, translucent. Whorls about 5, rapidly increasing, well rounded, sutures well impressed. Embryonic whorls with fine radial striae, becoming stronger on later whorls; upper surface of last whorl with irregular radial striae which continue onto the sides, overlayed with close, minutely papillose spiral threads. The lower surface is nearly smooth. Umbilicus very small, sealed with hardened slime. Aperture a little wider than high, lunate, with a white lining. Peristome somewhat oblique, sharp, slightly reflected over the umbilicus.

Height 11.8 mm. Diameter 20.3 mm. Spire width 11 mm. Aperture width 10.7 mm. Aperture height 9 mm. Holotype.

Penis rather short, fusiform, without an appendix, of uniform texture throughout its length, interior uniformly papillose, without pilasters. Penial retractor muscle long, slender, attached at

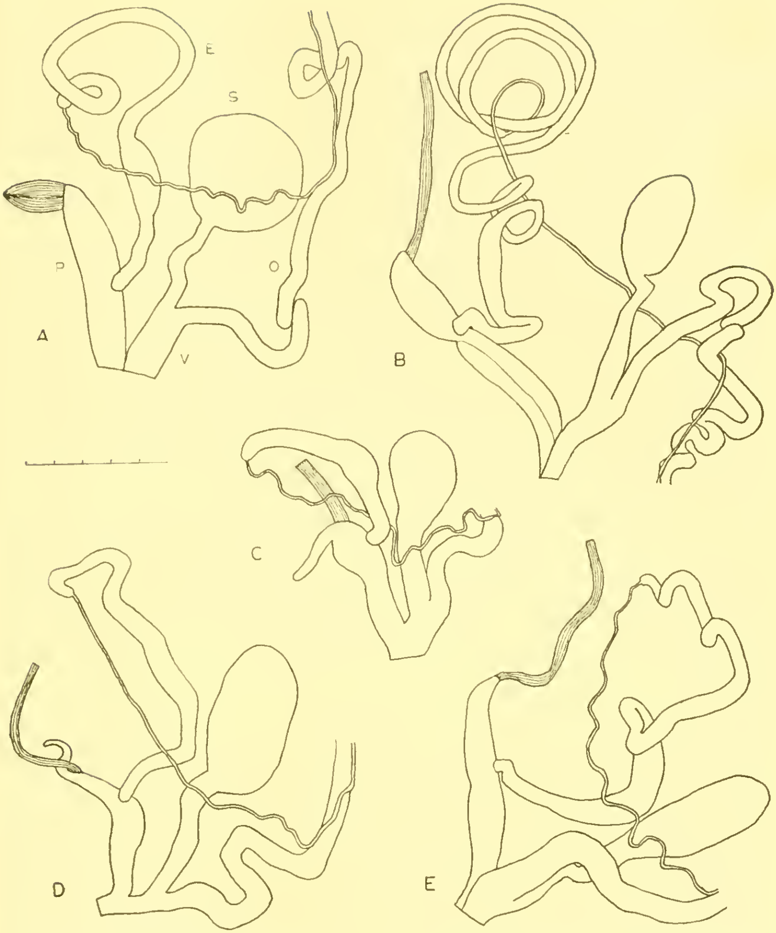


Fig.1. A., *Mesomphix vulgatus* H. B. Baker, topotype. B., *Mesomphix derochetus* Hubricht, holotype. C., *Mesomphix ruidus* Hubricht, paratype. D., *Mesomphix globosus* (MacMillan), topotype. E., *Mesomphix anurus* Hubricht, holotype. e. epiphallus. o. free oviduct. p. penis. s. spermatheca. v. vagina. Scale line 5 mm.

the end of the penis. Epiphallus entering the penis near the middle, about 3 times as long as the penis, the lower third much enlarged, being larger than the penis. Spermatheca large, ovoid, duct short. Free oviduct about as long as the penis. Vagina very short, about as long as wide. Atrium very short, only reaching through the integument.

Penis 9 mm. Epiphallus 24 mm. Spermatheca duct 4.3 mm. Vagina 1.5 mm. Free oviduct 9.3 mm. Holotype.

Distribution.—*Kentucky:* Warren Co.: Barren River bluff, 2 miles northeast of Bowling Green. *Tennessee:* Montgomery Co.: near Coleman Cave, 5 miles, southwest of Woodlawn. Sumner Co.: hillside, 1.7 miles south of Bransford. Macon Co.: ravine, 4 miles southwest of Lafayette; hillside, above Ann White Cave, 6 miles west of Lafayette, holotype 111660 and paratypes 111661, Chicago Natural History Museum, other paratypes 18296, collection of the author. Smith Co.: Cumberland River bluff, 1 mile southeast of Carthage. DeKalb Co.: Caney Fork River bluff, Sligo Landing, dry hillside, 0.8 mile southeast of Dowelltown. Grundy Co.: Big Mouth Cave Sink, 4 miles northeast of Pelham; side of Cumberland Mtn., 1.5 miles north of Monteagle. Marion Co.: hillside above spring, Martin Springs; hillside above spring, 2 miles south of Martin Springs. *Alabama:* Madison Co.: Monte Sano State Park, east of Huntsville. Jackson Co.: side of Keel Mtn., Paint Rock.

The shell of *Mesomphix anurus* differs from that of *M. vulgatus* in being yellower and more glossy, with more slender, more loosely coiled whorls and deeper sutures. Anatomically it differs in the longer, more slender penial retractor muscle, in the more enlarged basal third of the epiphallus, and in the shorter free oviduct.

MESOMPHIX DEROCHETUS, new species. Pl. 1, B; fig. 1, B.

Shell depressed with low spire; pale brownish-yellow above and below, dull and opaque. Whorls about 5, rapidly increasing, well rounded, sutures moderately impressed. Embryonic whorls with distinct radial striae, not increasing much in later whorls, base nearly smooth. Last two whorls covered with close, minutely papillose spiral threads. Umbilicus very small, sealed with hardened slime. Aperture a little wider than high, lunate, with a white lining. Peristome somewhat oblique, sharp, slightly reflected over the umbilicus.

Height 12.1 mm. Diameter 23.2 mm. Spire width 12 mm. Aperture width 12 mm. Aperture height 10.1 mm. Holotype.

Penis rather short, club shaped, projecting slightly beyond the insertion of the penial retractor muscle; above the insertion of the epiphallus it is thick and rigid, below it is somewhat flattened and flexible; within there is a single pilaster which extends the entire length of the penis. Penial retractor muscle long and slender. Epiphallus very long, about 5 times the length of the penis, somewhat enlarged above its junction with the penis, the rest rather slender, joining the penis near the middle. Spermatheca

large, ovoid, duct short, somewhat enlarged basally. Free oviduct from 2 to 3 times as long as the penis. Vagina about 1/3 as long as the penis. Atrium very short, only reaching through the integument.

Penis 10 mm. Epiphallus 47 mm. Vagina 3.7 mm. Spermatheca duct 5 mm. Free oviduct 23 mm. Holotype.

Type locality.—*Kentucky:* Mercer Co.: Kentucky River bluff, 1 mile northeast of Shakertown, holotype 111658 and paratypes 111659, C.N.H.M., other paratypes 13394, collection of the author.

The shell of *Mesomphix derochetus* differs from that of *M. vulgatus* in having the striae on the last whorl finer and the papillose spiral threads coarser. The real differences are in the anatomy. The very long epiphallus, equal in length to twice the diameter of the shell, will distinguish it from any other described species. The penis is clearly divisible into an upper and a lower section, and the longer and more slender penial retractor muscle is attached to the penis a little below the end.

MESOMPHIX PERLAEVIS (Pilsbry).

The range of this species was found to be much greater than was previously believed. It ranges from northern Georgia through western North Carolina, eastern Tennessee, eastern Kentucky, West Virginia, western Maryland, to southwestern Pennsylvania.

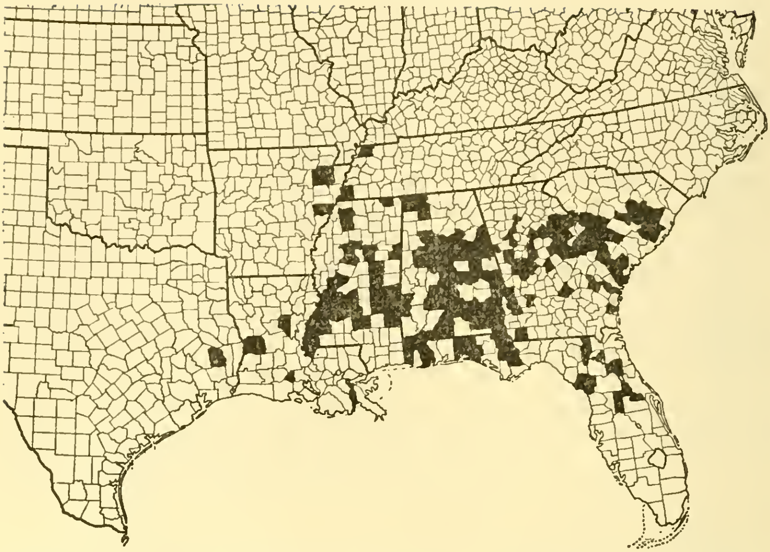
Pilsbry (Land Moll. N. Amer. II, p. 321.) refers to the penial appendix in this species as being lateral. However, it is terminal. The base of the penial retractor muscle is much expanded and in fully mature animals is not always clearly differentiated from the penis, and appears as an extension of the penis. The appendix is not always present. When it is absent, the species can be readily distinguished by the very broad terminal portion of the penis, the broad base of the retractor muscle, and the short epiphallus.

MESOMPHIX LATIOR (Pilsbry).

Mesomphix latior monticola Pilsbry, 1946, Land Mollusca of North America (North of Mexico). Acad. Nat. Sci. Phila. Monogr. 3, vol. 2 (1): 322-323, fig. 163d-e, 164, 165.

The penis of *M. latior* is very similar to that of *M. ruidus* but the appendix is shorter and the retractor muscle is heavier.

The difference in the shells between *Mesomphix latior* and *M. l. monticola* is no greater than is to be found in other species of *Mesomphix*.



Map 1. Distribution of *Mesomphix globosus* (MacMillan), as represented by specimens in my collection.

Mesomphix latior ranges from the mountains of northeastern Alabama to southwestern Virginia.

MESOMPHIX GLOBOSUS (MacMillan). Pl. 1, D & E; fig. 1, D.

Omphalina pilsbryi globosus MacMillan, 1940. Amer. Midl. Nat. 23: 732, fig. 1.

Mesomphix pilsbryi globosus (MacMillan), Pilsbry, 1946, Land Moll. N. Amer. II, p. 343, fig. 177e-f.

Mesomphix vulgatus form *hartwrighti* Pilsbry, 1946, Land Moll. N. Amer. II, p. 326. figs. 166c, 167f.

A study of the anatomy of topotypes of *M. globosus* shows that it is not related to *M. pilsbryi* (Clapp), but to *M. ruidus* Hubricht. The following anatomical description is based on specimens collected near the Santee Canal, 2.5 miles northeast of Moncks Corner, Berkeley Co., South Carolina.

Penis rather short, fusiform, with a distinct appendix, which varies from 1/4 to 1/2 as long as the penis. Interior of penis uniformly papillose without pilasters. Penial retractor muscle long and slender. Epiphallus from 2 1/2 to 3 times as long as the penis, somewhat expanded in the middle; entering the penis near the middle. Spermatheca large, ovoid; duct short, rather thick. Free oviduct about 3 times as long as the penis. Vagina very short. Atrium short.

A, *Mesomphix vulgatus* H. B. Baker. B, *M. derochetus* Hubricht, holotype. C, *M. anurus* Hubricht, holotype. D, E, *M. globosus* (MacMillan). F, *M. ruidus* Hubricht, paratype. Photographs by Chicago Natural History Museum.

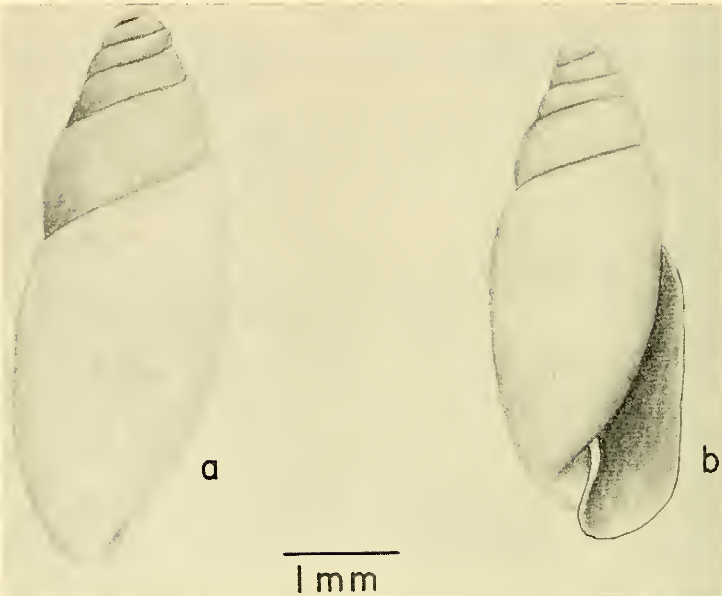


Figure 1, a, b, *Streptostyla maslini* Branson & McCoy.

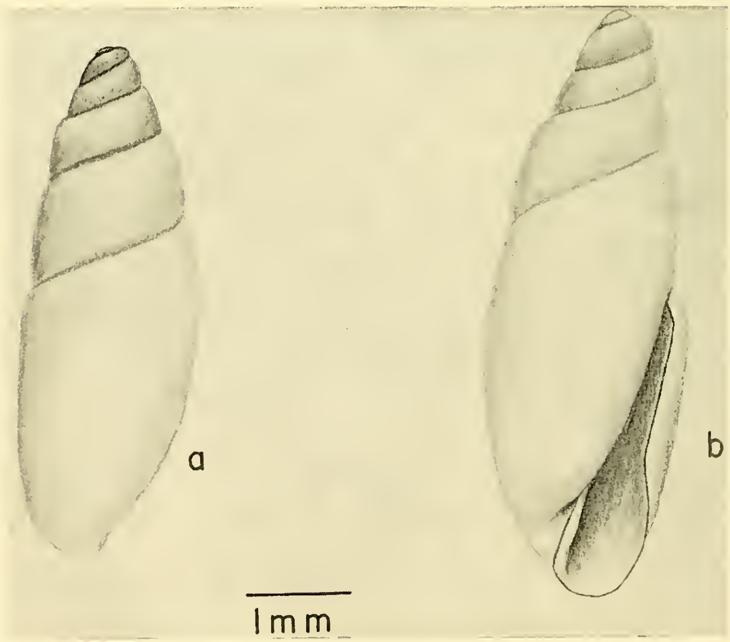


Figure 2, a, b, *Streptostyla toltecorum* Branson & McCoy.

Penis 5.3 mm. Epiphallus 14 mm. Spermatheca duct 5 mm. Vagina 1 mm. Free oviduct 15 mm. Atrium 1 mm. Topotype.

Mesomphix globosus is the most widely distributed species of the *vulgatus* group. It ranges from coastal South Carolina to northern Florida and westward to eastern Arkansas and Texas. Map no. 1.

The shell of *Mesomphix globosus* can usually be distinguished from that of *M. vulgatus* by its more elevated spire, more rounded whorls, coarser sculpture, and darker color. But it is quite variable and some shells have very low spires and the dark color of the upper surface is sometimes absent. Such shells can not be distinguished from *M. vulgatus.* The presence of a distinct appendix to the penis will always distinguish it from *M. vulgatus* or *M. anurus.* It cannot always be distinguished from *M. ruidus* by the shell. The epiphallus and free oviduct are much shorter in *M. ruidus.* The shell shown in pl. 1, fig. D., is from near Savannah River, 17 miles northeast of Sylvania, Screven Co., Georgia, and that in fig. E from a ravine, 3 miles northwest of McKenzie, Butler Co., Alabama.

Mesomphix ruidus Hubricht. Pl. 1, fig. F; fig. 1, C.

This species has been found at the following localities in addition to those published with the original description (Trans. Kentucky Acad. Sci. 19: 74. 1958).

Kentucky: Meade Co.: near Otter Creek, Garnettsville, west of Muldraugh. Hart Co.: near Cane Creek, at Ky-728, Roseburg. Edmonson Co.: near Green River, 0.5 mile north of Potato Hill, near Brownsville. *Tennessee:* Rutherford Co.: roadside, 2 miles north of Fosterville.

STREPTOSTYLA TOLTECORUM AND S. MASLINI, SPP. NOV., FROM MEXICO*

By BRANLEY A. BRANSON, Kansas State College, Pittsburg and CLARENCE J. McCOY, JR., University of Colorado Museum, Boulder.

The junior author and a party of zoologists from the University of Colorado Museum, primarily concerned with heterothermous vertebrates, collected several mollusks in Yucatan, Campeche and other Mexican states during the summer and winter of 1961. Among these were specimens which are considered to be two new species. These are described below. The other

* Supported in part by NSF Grant G-16244

species will be reported upon in a later paper.

STREPTOSTYLA MASLINI, new species. Plate 2, fig. 1 a, b.

Stations: Airport, Ciudad del Carmen, Campeche; 16:vi:1961; and 19 miles east of Merida, Yucatan; 19:vi:1961. Holotype, Museum of Zoology, University of Michigan 210557. 2 Paratypes, University of Colorado Museum 26245. Paratype, senior author's collection 6544. Type Locality: 19 miles east of Merida, Yucatan, Mexico.

Shell thin, translucent, moderately bulliform, uniformly horn colored; very polished and smooth; ultimate whorl bears a few nearly obsolete, sinuous growth striae which roll into the aperture; spiral striation lacking. Apex parabolic, very smooth and appears to have been slightly deflected to the left; embryonic whorls 1½, not visible from a posterior view; total whorls 5½, all, except the ultimate one, which suddenly increases in size, very smooth and somewhat slab-sided; 4 sutures visible from frontal view; all whorls beveled below sutures and bear a fairly thick transparent calcareous deposit. A deep sulcus proximally paralleling the slightly twisted and thickened columella, leads into a small umbilicus; sulcus and columella white; outer peristome thin and slightly sinuous. Total length 10.mm; greatest diameter 4.0 mm; spire length 2.5 mm; aperture length 6.0 mm; greatest width of aperture 1.6 mm.

Indices: Length/diameter—2.5. Length/spire—4.0. Length/aperture length—1.67. Spire/aperture width—3.75. Ultimate whorl depth/penultimate whorl depth—6.8.

This form is a member of a species complex which includes *S. ventricosula* (Morelet) (Yucatan), *S. yucatanensis* Pilsbry and *S. pilsbryi* Richards (Cozumel). Its short spire, glossy texture and growth striae bounded toward the aperture indicate that it is more closely related to *S. pilsbryi* than to the others. It differs from *S. pilsbryi* in being slightly smaller, in having a much shorter and narrower aperture and in having a better developed columellar fold and much more restricted growth sculpture.

STREPTOSTYLA TOLTECORUM, new species. Pl. 2, fig. 2 a, b.

Stations: Five to 11 miles east of Campeche, Campeche; 16:vi:1961. Holotype, Museum of Zoology, University of Michigan 210558. Paratype (immature), Museum of Zoology, University of Michigan 210559. Paratype (immature), University of Colorado Museum 26246. Paratype, Academy of Natural Sciences of Philadelphia. Type Locality: 5 miles east of Campeche, Campeche, Mexico.

Shell moderately thin, translucent; uniformly whitish-horn in

color; very smooth and moderately glossy; ultimate whorl practically smooth; growth striae very faint to lacking completely; no spiral sculpture. Apex parabolic, smooth and straight; embryonic whorls nearly two, visible both posteriorly and anteriorly; 4½ whorls, all smooth and evenly rounded; four sutures visible anteriorly; whorls below sutures only slightly beveled; calcareous deposits near sutures very thin; proximal sulcus short and much wider below than above; short, nearly straight, columella (wider below than above) and sulcus lighter, but of same color as rest of shell; outer peristome thin and nearly straight. Total length 9.5 mm; greatest diameter 3.5 mm; spire length 3.0 mm; aperture length 5.25 mm; greatest width of aperture 2.0 mm.

Indices: Length/diameter—2.71. Length/spire—2.17. Length/aperture length—1.80. Spire/aperture width—1.50. Ultimate whorl/penultimate whorl depth—5.3.

In general contour this species is reminiscent of *S. meridana* (Morelet), with which it is assumed to be mostly related. It differs from the latter in being taller and more slender; in having a relatively longer spire and more narrow aperture and a much shorter and more truncate columella.

GONAD DEVELOPMENT AND SPAWNING OF BRACHIDONTES RECURVUS IN CHESAPEAKE BAY

By J. FRANCES ALLEN

(Concluded from April no.)

During the period from January 16, 1950, through April 16, 1951, the temperature ranged from 1.8° C. to 24.5° C., and the salinity from 16.24 o/oo to 2.85 o/oo (Parts per 1000). See table II and graphs. As would be expected, the higher temperature prevailed during the summer period, and the lower temperature during December, January, and early February. The highest salinity of 16.24 o/oo was recorded on October 9, 1950 and the lowest salinity 2.85 o/oo on February 19, 1951. The lower salinities occurred during spring and summer, whereas, the higher salinities prevailed during the fall and winter. The salinities of the spring of 1950 were not as low as those of the corresponding dates in 1951. On February 16, 1950, it was 11.6 o/oo, while on February 19, 1951, it was 2.85 o/oo. The latter condition is considered abnormal in the area and was due to the heavy spring rains. The temperature varied from a high of 24.5° C. on July 31, 1950 to a low of 1.8° C. on February 19,

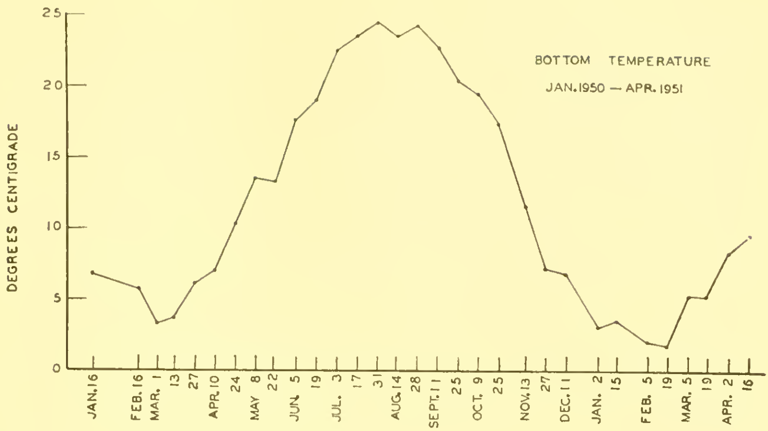
TABLE II

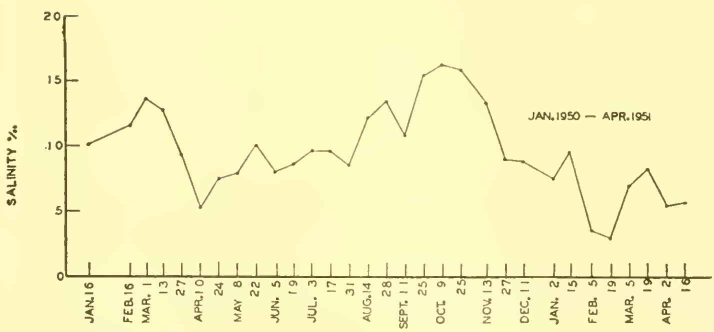
BOTTOM TEMPERATURE AND SALINITY AT HACKETT'S BAR
JANUARY 16, 1950 THROUGH APRIL 16, 1951

DATE	TEMPERATURE ° C.	SALINITY o/oo
1950 - Jan. 16	6.8	10.10
Feb. 16	5.7	11.60
Mar. 1	2.7	13.60
13	3.6	12.70
27	6.1	9.30
Apr. 10	7.0	5.20
24	10.3	7.50
May 8	13.6	7.90
22	13.3	10.10
Jun. 5	17.7	8.00
19	19.0	8.64
Jul. 3	22.5	9.64
17	23.5	9.63
31	24.5	8.51
Aug. 14	23.5	12.05
28	24.3	13.44
Sept. 11	22.8	10.75
25	20.4	15.41
Oct. 9	19.5	16.24
25	17.4	15.81
Nov. 13	11.6	13.28
27	7.2	8.86
Dec. 11	6.8	8.77
1951 - Jan. 2	3.1	7.48
15	3.6	9.47
29	2.1	3.84
Feb. 5	2.1	3.48
19	1.8	2.85
Mar. 5	5.3	6.91
19	5.2	8.21
Apr. 2	8.4	5.44
16	9.6	5.84

1951. In early June 1950, the temperature was 17.7° C., rising to a high of 24.5° C. on July 31, 1950, finally dropping to 11.6° C. on November 13, 1950.

It was observed that spawning began in early June at a temperature of 17.7° C. and continued throughout the summer and fall, at least until the middle of November when the temperature had dropped to 11.6° C. The older larvae present during





December were able to survive at a temperature as low as 6.8° C. recorded on December 11.

The data presented with respect to larval distribution leads to the conclusion that the spawning period of *B. recurvus* extends from early June until November. The greater number of larval stages was observed in late summer which indicates that the greater percentage of setting takes place during late August and September. This observation is supported by the observa-

tions on the development of the gonads and the small size range of the mussels collected in October.

The distributional data on the larval stages also point to the existence of three relatively distinct periods of spawning: an early spawning in June, a mid-season spawning in late July and August, and a late spawning in November. As noted (table I) in following the seasonal variation of the pre-hinge stage, the larval stages increase during June and early July, but are then absent from the plankton. They occur in abundance during August and September, but are again absent in late October. Finally, they are present in mid-November. This seasonal pattern of distribution is followed also by the hinge and post-hinge stages. Acceptance of the three distinct spawning periods would explain the absence of the post-hinge stage during late July and early August.

Explanation of three such periods on the basis of environmental factors is not possible. Whedon (1936) and Young (1942, 1946) reported similar observations on *Mytilus californianus.* Numerous other investigators have made similar observations on other species of pelecypods, and have shown that either a rise or a drop in temperature may induce spawning in these forms (Berner 1935). In lamellibranchs, spawning is usually associated with rising temperature. The conclusion of Pelseneer (1938) and Nelson (1928b) is that when a critical temperature is reached, spawning occurs above that point, but below that temperature it does not occur. Galtsoff (1938, 1940), however, points out that in the oyster, "There exist several 'critical' temperatures for spawning of males and females, apparently determined by their physiological conditions . . . The idea (therefore) of a single critical temperature effective in inducing spawning in all oysters of a given population . . . should be abandoned."

Possibly, considering the long period of sexual maturity of the gonads in *B. recurvus,* the physiological conditions result in different spawning periods for individual mussels.

Discussion: The gross morphology of *Brachidontes recurvus* is apparently the same as that observed by Field (1922) for *Mytilus edulis* and as that given by Wiborg (1946) for *Modiola modiolus* Personal observation has indicated that the same is true for

Modiolus = *Volsella demissus.*

The location of the gonad tissue in the curved mussel is essentially the same as that observed in the above mentioned forms. Wiborg (1946) states that in *Modiola modiolus* the gonad tissue has the same arrangement as in the sea mussel with the exception of the mantle lobes which are thin and membrane-like, similar to the condition existing in the young sea mussel. The gonad tissue, however, of *B. recurvus* does penetrate into the mantle to such an extent that at the time of maturity the mantle is actually a large gonad.

Coe (1943) observed that the majority of pelecypods have separate sexes with an occasional hermaphrodite making its appearance. He found that a study of juveniles was necessary to ascertain the sexual condition of the individual. In addition to these two forms, examination was made of specimens of *Modiolus demissus, Mytilus edulis,* and *M. californianus.* In none of these species did he find any evidence of ambisexuality except in undifferentiated gonads and only an occasional hermaphrodite. The occurrence of males and females was about equal. Wiborg (1946) found that the sexes of *Modiolus modiolus* are usually separate with hermaphrodites occurring in 2 to 8% of the individuals. In some hermaphrodites of this species, the female tissue is located as a ball in the middle of the mesosoma and is surrounded by the male tissue, while in others the male and female tissue is evenly distributed.

In *B. recurvus,* resemblance to the above forms is evident in that the sexes are separate in those observed and are also approximately evenly divided. Of all the specimens examined, there were no hermaphrodites and there was no ambisexuality.

Loosanoff and Davis (1951) have observed resorption of gonad tissue following spawning in *Mercenaria* = *Venus.* This condition was not noted in any of the curved mussels; the reproductive tissue merely becomes degenerate.

The protracted spawning period is similar to conditions reported by Young (1946) on *Mytilus californianus* although different seasons of the year are involved. Engle and Loosanoff (1943) discuss the setting of *M. edulis* from early June to the end of August at Milford, Conn., thus indicating a relatively short spawning period for this form. Battle (1932), while as-

sociating spawning of *M. edulis* and *Macoma balthica* in Passamaquoddy Bay with lunar tidal cycles, gives their spawning period as extending from mid-June to mid-September. Sullivan (1948) notes the occurrence of larvae of *Mytilus edulis* from late May until the end of August in Malpeque Bay. In regard to the instances mentioned, the spawning period of *B. recurvus* in Upper Chesapeake Bay extends at least 2 or 3 months longer than that of the forms previously mentioned.

Wiborg (1946) says that *Modiolus modiolus* spawns in March and April and that spawning may be completed within a single day, all individuals in a specific bed spawning simultaneously. This is not true of the curved mussel at Hackett's Bar, as spawning continues there throughout the summer and fall.

The question of critical temperatures and spawning of the curved mussel has already been considered. The observations reported in this study support those of Young (1946) and others on *Mytilus californianus*. Nelson (1928b) who reported that lamellibranchs fall within the group which breed at a definite temperature, observed that the curved mussel spawns along the coast of New Jersey when the water temperature reaches 25° C. I observed that *B. recurvus* spawns at much lower temperatures in the upper Chesapeake Bay. The highest temperature recorded during the period of this study was 24.5° C.

Summary

Specimens of the curved or hooked mussel, *Brachidontes recurvus* (Rafinesque), used in this study were collected from Hackett's Bar, located on the western shore of the Chesapeake Bay, approximately two nautical miles above the mouth of the Severn River.

A group of mussels representing the size range at each collection from March, 1959, through April, 1951, were fixed in Bouins and stained with hematoxylin and eosin or with Mallory's Triple stain for examination of the gonads and internal anatomy.

Plankton samples were taken simultaneously with collection of mussels in order to determine the seasonal distribution and relative abundance of the larval stages. At the same time, determinations of salinity and temperature of the water just above the bar were made.

B. recurvus is dioecious and does not show alternation of sex

or hermaphroditism in any specimens examined. The gonad tissue of both sexes of the mussel, when mature, occupies the entire mantle and mesosoma and penetrates into the digestive diverticula, where it is found adjacent to the liver canals. There is no evidence of resorption as it occurs in some bivalves.

Sexual maturity exists from June through October, and perhaps even longer in some cases. Spawning occurs from June until November with the greater degree of the spawning in summer and early fall.

Spawning is not influenced by any single critical temperature.

Literature cited

Abbott, R. T. 1954. American Seashells. Van Nostrand, New York. 541 pp.

Battle, H. I. 1932. Contr. Canad. Biol. and Fish. *7:* 257-275.

Berner, L. 1935. Bull. Inst. Oceanogr. *680:* 1-8.

Beaven, G. F. 1947. Observations on the fouling of shells in the Chesapeake Bay area. Address Nat. Shellfish Assoc.: 13-15.

Chestnut, A. F. 1949. The oyster industry of North Carolina and some of its problems. Address Nat. Shellfish Assoc.: 39-42.

Coe, W. R. 1943. Quart. Rev. Biol. *18:* 154-164.

Engle, J. B. and V. L. Loosanoff 1943. Anat. Rec. *87:* 12.

—— 1948. The condition of natural reefs and other public oyster bottoms of Alabama in 1943 with suggestions for their im provement. Spec. Sci. Rept. No. 29 Fish and Wildlife Serv., U. S. Dept. Int. 42 pp.

—— 1948. Investigation of the oyster reefs of Mississippi, Louisiana, and Alabama following the hurricane of September 19, 1947. Spec. Sci. Rept. No. 59 Fish and Wildlife Serv., U. S. Dept. Int. 71 pp.

Field, I. A. 1922. Bull. U. S. Bur. Fish. *38:* 127-259.

Frey, D. G. 1946. Oyster bars of the Potomac River. Spec. Rept. No. 32 Fish. and Wildlife Serv., U. S. Dept. Int. 93 pp.

Galigher, A. E. 1934. The Essentials of Practical Microtechnique. Albert E. Galigher, Inc., Berkeley, Calif. 288 pp.

Galtsoff, P. S. 1938. Biol. Bull. *75:* 286-307.

—— 1940. Biol. Bull. *78:* 117-135.

Littleford, R. A., C. L. Newcombe, and B. B. Shepherd 1940. Ecol. *21:* 308-322.

Loosanoff, V. L. and H. C. Davis 1951. Jour. Mar. Res. *10:* 197-202.

Nelson, T. C. 1928a. Biol. Bull. *55:* 180-192.

—— 1928b. Sci. *67:* 220-221.

Newcombe, C. L. and H. Kessler 1936. Ecol. *17:* 429-443.

Pelseneer, P. 1935. Essai d'Ethologie Zoologique d'apres L'etude dos Mollusques. Acad. Roy. de Belgique. Classe des Sciences. Fondation Agathon de Potter., No. 1. 662 pp.
Sullivan, C. M. 1948. Bull. Fish. Res. Bd. Canad. *77:* 1-36.
Whedon, W. F. 1936. Univ. Calif. Publ. Zool. *41:* 35-44.
Wiborg, K. F. 1946. Undersokelser over obskjellet *(Modiola modiolus).* Fisk. Direct. Skrif. *8:* 1-85.
Young, R. T. 1942. Ecol. *23:* 490-492.
—— 1946. Ecol. *27:* 354-363.

PUERTO RICAN LAND OPERCULATES

By H. BURRINGTON BAKER

The symbols for Puerto Rican localities have been explained recently (1961).

Alcadia (Striatemoda) striata (Lamarck) and form *subfusca* (Menke). Typical form (with thickened peristome) infrequent; shells usually yellowish unicolor (En1, Er3, Es4, Jn1, Pr1-3, Wr3) but also bicolor fulvous, with light sutural and (weaker) peri pheral bands and basal spot (Pr6, Ps2, Wn, Wr3; and Ws, but paler); good climber, up to 10 ft.; males and females subequal in size. Paedogenetoid (with "immature" shell but often sexually mature) form *subfusca* common, almost everywhere. (Ee, Es, Jn, Js, Pn, Pr, Ps, Wn, Wr, Ws); climbing but also under leaves on ground, 0-4000 ft. Animal dark above, bluish black on dorsum of head and tentacles; tail lighter, attenuate; sole weakly tripartite; secretes copious mucus.

Alcadia (Hjalmarsona) hjalmarsoni (Pfeiffer). Terrestrial; Pr3, 4, 6, Wr; western highlands, 1800-3400 ft.; males and females subequal in size; shell uniformly yellowish, tinged with fulvous, which becomes stronger near peristome. Animal greenish, with dark olive blotches and darker tentacles; sole weakly tripartite.

Alcadia (Schrammia) alta (Sowerby). Subarboreal, aestivating in dead *Cecropia* leaves, caught in vines, etc., 4-10 ft. above ground; Es, Jn, Pn, Pr; 100-4000 ft.; absent from wettest (Er) and driest places; males commonly smaller and higher but intergrading widely with females; yellowish and fulvous forms subequal in numbers, but some lots all fulvous. Foot with some grayish blotches on sides; sole as in preceding.

Helicina (s. s.) phasianella "Sowerby" Pfeiffer. Rare, but good climber up trees on dampish lowlands (En, Jn, Ws; 0-400 ft.) but commoner and subarboreal (often roosting in folded pinnae of palms) at western (driest) end of Cordillera Central (Wr3, around 3000 ft.); males and females subequal in size. Shell color

ranging from light unicolor (only Wr3) with trace of chalky white, peripheral band (most constant feature) through very variable patterns of spiral bands and/or flammulations, to almost solid fulvous (1 shell). Animal with attenuate, leaf-like tail.

Lucidella (Poenia) umbonata (Shuttleworth). Weak climber on driest limestone rocks, Ps, Wn, Ws and Mona Island (Clench, 1951); fulvous color form commoner than yellowish; no data on sexes yet.

L. (Poeniella) plicatula vinosa (Shuttleworth, 1854: 92). Terrestrial, En, Jn, Pn, Pr, Wr, Wn, Ws, Ww, 0-4000 ft.; apparently absent from wettest (Er) and driest (Ps) places; fulvous *(vinosa)* color form commoner than yellowish; no data on sexes. Shell smaller (down to maj. diam. 3 mm.) than typical *plicatula,* especially in lowlands (near San Juan, Js1, now selected as type locality) but attaining maj. diam. 4.1 mm. with 4¾ whorls in highlands (Pr), rounded to subangulate, with rounded or flattish growth riblets, separated by interspaces (varying in same lot) from 1 to over 2 times their width above periphery of last whorl (more widely spaced below); umbilical callus varying (apparently with age) from depressed and punctulate (Cf. van der Schalie, pl. 1, figs. 5) to convex and almost smooth; with basal peristome varying similarly from slenderly sinuous (figs. cited) through (commonly) strongly swollen to (weakly and rarely) subdentate; fresh ones with sharp, submicroscopic, spiral striae, most evident in interspaces but weakly surmounting growth riblets.

Obviously, this small species is transported adventitiously and, because of variation in these lots, the following (at least) are considered conspecific, although larger series may prove them also to be island subspecies:

Vieques: ANSP. 14836, *vinosa* (Riise!). St. Kitts, Leeward Is.: ANSP. 62062, type lot of "var." *christophori* (Pilsbry, 1897 (3): 118, but used by me, 1923, as species or subspecies): sizeable series of youngish (depressed umbilical callus) but mature, fresh whells varying from size of *plicatula* (maj. diam. 5 mm., with 4½ whorls and even more "subdentate" than Pfeiffer's, Conch. Cab., pl. 8, figs. 39-42; not 36-39) to (rarely) size and form of *vinosa*. Guadeloupe: 2 small lots; ANSP. 14798 (Grasset!) about size of *plicatula* (so labeled) but not markedly subdentate; ANSP. 14785 (Marie!) whitish whells size of *vinosa* (labeled *euglypta*). Martinique: no shells seen, but type locality of *Helicina plicatula* Pfeiffer, 1849, and of *H. euglypta* Crosse, 1874 (influenced by Franco-Prussian war?). St. Lucia: *L. denseplicata*

A. J. Wagner, 1910, Conch. Cab.: 348, pl. 69, figs. 14 & 15. St. Vincent: "*H. rugosa* Pfr." E. A. Smith, 1895, Proc. Malac. Soc. London *1:* 311, with *vinosa* and *ignicoma* as synonyms? Trinidad: *H. ignicoma* Guppy, 1868, apparently founded on youngish shells, but maj. diam. 4.5 mm. Barbados: ANSP. 14783, labeled "*H. conoidea* Pfr., var." by Bland. Santo Domingo, northeast coast: *L. (P.) samana* Pilsbry, 1928 (24) : 481, pl. 27, figs. 6 & 7; type shell with only traces of spirals because obviously subfossil and apparently with calc. deposit. Gonave I., Haiti: *L. (P.) gonavensis* Pilsbry, loc. cit., figs. 8 & 9; type shell bleached.

L. (P.) barbadensis (Pfeiffer, 1854) from Barbados. Distinct species, but probably a *Poeniella,* with mainly much finer but more irregular, growth threads. Includes ANSP. 14916 from Bland (labeled *barbadensis*) ; 85468 (L. B. Brown, 1903!) ; 14926 from Swift (labeled *H. conoidea* Pfr.?) ; briefly keeled and decidedly angulate to higher shells which are less angular; varying from 3.1 to 5.7 mm. in diam.; approaching *H. conoidea* Pfr., 1854, and *L. holoserica* A. J. W., 1910: 350, pl. 69, figs. 16-19, but at least slightly angulate, often lighter at periphery but never with as sharp a peripheral band as in Wagner's figs. (but not mentioned in his description) ; both fulvous and yellowish forms. (*H. grenadensis* Smith, 1895: 318, pl. 21, figs. 16-18, from Grenada, seems similar to *conoidea.*)

Fadyenia (s. s.) portoricensis (Pfeiffer). On and under rocks and superfically on dead leaves; Pn2, Wn, Wr2, 3; 0-3000 ft.; both yellowish and fulvous color forms present. Sole tripartite, with 1 or 2 coarse waves on middle area.

Typical *Fadyenia* probably is carried adventitiously; it also occurs in Venezuela. In fact, *F. portoricensis* is quite similar to the variable *F. lindsleyana* (C. B. Adams), and possibly some of Chitty's obsolete Jamaican "species" may prove to be synonyms of it.

Ceratodiscus portoricanus Pilsbry & Vanatta. Quite deep in leaf humus; Pn, Pr3, 5, Wr, 100-3000 ft. west of San Juan; yellowish form commoner than fulvous. Shell (held upright like in planorbids) with two, serrate, spiral flanges of attached mud (like in *Fadyenia*); sole more weakly tripartite than in *Fadyenia,* but with similar locomotion.

Stoastomops (s. s.) puertoricana H. B. Baker. Only known from type locality (Ps2) and Mona Island (Clench, 1951) but easily missed because of excellent camouflage; however special searches were made for it on the northern limestone, especially where *Pseudopineria,* which also covers itself with limestone dust, was collected; color forms and habitats discussed when

described (1941c: 1). Foot whitish. Other two known species from Jamaica and Curacao.

S. (Swiftella) boriqueni H. B. Baker. Only known from type locality (Ws) and discussed when described (1941c: 2).

Megalomastoma (s. s.) verruculosum (Shuttleworth). Er3, empty shells frequent in one small area, about 2000 ft. elevation; see notes quoted by van der Schalie (1948: 30). The one male animal has a short foot and salmon-pink tentacles.

M. (Nesopupina) croceum (Gmelin). Burrowing; En, Es2, Jn, Pn, Wn; males averaging smaller but extensively intergrading in size with females; no differences in the animal from that of *hjalmarsoni* were noted.

M. (N.) croceum hjalmarsoni Pfeiffer. In dirt; Pr, Wr, 2000-4000 ft. in Cordillera Central; relative differences between sexes much as in *croceum*. Animal with whitish triangle on back of head; foot darker on sides and sole slate color; apparently sluggish (or timid) since my notes despairingly state: "None move."

Most of my lots of the highland and lowland forms could be separated on size alone, if sex differences be taken into consideration, although those from Pr6 and Wr2 are intermediate in size. Like most burrowing snails, the shells of living adults of typical *croceum* are devoid of epidermis, and even of patches of ostracum, so that they look like "bones." No examples of this species were seen above 1500 ft. elevation in the Luquillo Mts. All examples of *hjalmarsoni* from Pr1 (4000 ft. elevation) and Wr3 (3000 ft.) and one shell from Wr2 retain the brownish to chestnut-olive epidermis, and traces are visible on some of the others (See 1943b: 106-107).

Crocidopoma (Amphicyclotulus) portoricense (O. Boettger). Not collected; although a few hours were spent above 1500 ft. on Rio Blanco (Er5), I was unaware of its description; it may be very local (like *M. verruculosum*) or extinct (most of the slopes below looked like grasslands).

Licina (Choanopomops) decussata (Lamarck) and approaching *senticosa* (Shuttleworth); type locality for latter, now selected, Vieques Island. Good climber on trees, off limestone (Ee; all *decussata;* 80% males out of 15 of which sex known); on limestone (En; intergrading with *senticosa,* van der Schalie's pl. 2, fig. 3; 59% males out of 92); on limestone cliffs (Jn2; 2 males, both nearer *senticosa*). Males considerably smaller but intergrading in size with females, as usual in American pomatiids.

L. (C.) DECUSSATA YAUCOI, new subspecies. Figs. 1

Shell similar to *senticosa* but ground color lighter, with

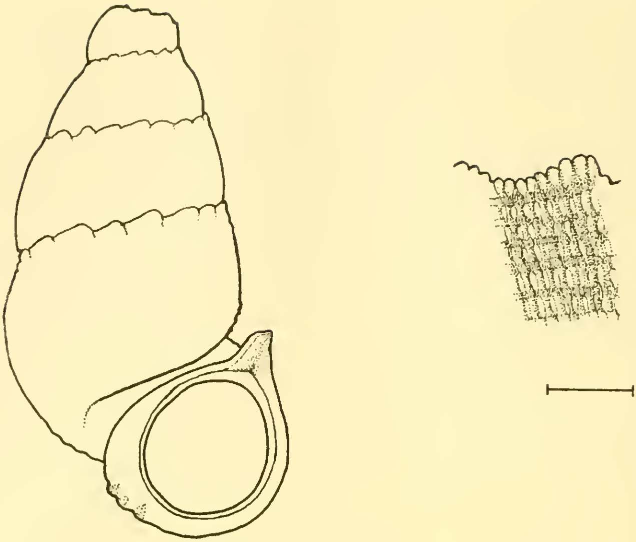


Fig. 1. *Licina decussata yaucoi* H. B. Baker. Type shell on left; detail of subsutural sculpture (scale = 1 mm.) at right.

stronger and more distantly spaced (7-8 per mm. on last whorl) growth riblets, which are broken almost completely by the spirals into elongate nodules; sutural crests almost confluent and becoming gradually higher in series of 9 to 11, so as to render suture serrate (rather than crenulate as in *senticosa*) ; peristome markedly duplex; outer one with high crest over parietal angle and broader on columellar side (often weakly crenulate). Type (female) shell: length 16.3 mm., maj. diam. 53 (8.7 mm.), minor diam. 45 (7.3 mm.) ; peristome (outside) 39 (6.3 mm.) by 57 (3.6 mm.) ; aperture (inside) 28 (3.0 mm.) by 83 (2.5 mm.) with 4 whorls remaining. ANSP. 256031. Type locality: east of Tallaboa (Ps1) ; 2 males and 3 females.

L. (C.) decussata yaucoi, var. a. Ps2: 1 male and 3 females. Ps3; on trees, 2-8 ft. up, during rain; 56% males out of 16; seen copulating. Riblets similarly spaced to *yaucoi* but much less broken into nodules by spirals; peristome less expanded and less crested (thus approaching *senticosa*).

L. (Chondropomops) aguadillensis (Pfeiffer). Weakly climbing on limestone rocks after rain, Wn; males 54% out of 156, but many accidentally mixed are excluded and these seem mainly males. Shells like van der Schalie's pl. 2, fig. 4, which resembles an old male, but commonly with less protruded inner peristome and often with lower crest above parietal angle; growth riblets finer and weaker than in *turnerae* and with their sutural crests

completely fused into clumps of 2 or more; outer peristome reflexed almost into plane of aperture.

L. (C.) aguadillensis turnerae (Clench), the "roughly sculptured" variety of 1941c: 3. Near Cerro Capron (Ps2) under and on top of limestone rocks; 62% males out of 42. Shells like Clench's, 1951, fig. 1, excellent photograph of (youngish female of?) this subspecies (from Mona I.) but, when fully developed, with more duplex peristome and higher parietal crests (but all less so than in typical *aguadillensis,* and with outer peristome more expanded than reflexed) and with sutural crests of riblets more accentuated (but separated), usually in pairs at irregular intervals.

L. (C.) aguadillensis turnerae, var. a. Ws; no data on habits, but 68% males out of 37. Somewhat intermediate between *turnerae* and typical *aguadillensis,* but closer to the former; accentuated, paired, sutural crests of riblets joined proximally but distinct at their edges.

The above 3 varieties are considered conspecific, but probably the late Dr. Bartsch would have described them as separate species, and I cannot prove their intergradation, perhaps because no collections were made at interposed localities. The operculum is as usually in *Choanopomops,* i.e., with the calcareous plate incomplete and much closer to the horny one than in *Choanopoma,* although often roughly parallel to it, as in the southern *Tudora* or in Jamaican *Colobostylus.* Dr. van der Schalie's figure of *senticosa* (cited above) also shows the calcareous plate of the operculum clearly, and its black border probably represents the protruding horny plate.

L. (C.) graminosa H. B. Baker. Terrestrial habits discussed in description (1941c: 3); apparently prefers deeper and rottener soil; Ps1 & 2.

Chondropoma (Chondropomorus) blauneri (Shuttleworth). Only found at what is now selected as the type locality, La Valvera, near Humacao (Es3). Apparently good climber on trees and not searched for under rocks, but, when animals were examined (months later) every living adult was a male.

These data seem to indicate that, at least during excessively dry weather, the males are more persistent climbers! As already indicated, the opercula of these Puerto Rican species approach those of the subgenus *Cistula* (+ *Parachondria* Dall); Cf. van der Schalie, pl. 2, fig. 4.

Chondropoma (Chondropomorus) yunquei H. B. Baker. Only known from type locality (Er2); habits and sizes discussed in description (1941c: 4); 71% males out of 24. Evidently closest to C.

conseptum (Martens), as figured by van der Schalie, 1948: pl. 2, fig. 8, from Aguas Buenas, and collections from the intervening 22 miles might show that intermediates exist.

Chondropoma (Chondropomorus) riisei (Pfeiffer). Good climber up to 10 ft. on trees; unlike two preceding species, only found by me on or near limestone; Jn, Wn (67% males out of 27). Described as a *Cistula.*

C. riisei newtoni (Shuttleworth). Abundant; good climber up to 10 ft. on trees and also on rocks; limestone canyon of Rio Grande de Arecibo; Pn1 (now selected as exact type locality; 57% males out of 122) and Pn2. Sides of foot pale greenish, shading into light chrome near sole; tentacles light but eyes black; "muzzle" streaked and spotted with dark olive; sole bipartite (as usual in pomatiids).

C. terebra Pfeiffer, 1861, appears to be a junior synonym, and his "Sierra Morales" about 10 miles southeast of this locality; from van der Schalie's (1948: 34) map for *C. riisei,* the latter may have collected there. About the only excuse for the retention of *newtoni,* even as a local race, is that it has a name.

Chondropoma (s. s.) schaliei H. B. Baker. Also on top of rocks, copulating; Pn1, 2; general habits given in description (1950: 18). Body slightly pinkish, with salmon tentacles.

Of the 149 samples of known sex in the type lot (Ps2) 63% are males. Statistically tested, this difference in numbers between the two sexes is very significant but, when correlated with the data on *C. blauneri,* it may indicate only that one can fail to make a random sample, even in a small area. At least, the preponderance of males obtained in all the largest lots of pomatiids, accentuates the need for great care in collection of samples, if ones wishes to use statistical methods in systematics.

Years ago, a lengthy mathematic study (unpublished) was made of a large series of *Allogona townsendiana minor* (or *ptychophora*), and the combined total gave a very platycurtic "curve," which was significantly bimodal largely because I had picked up every example of the rarer, but bigger and prettier, ecologic form *lombardi* (+ *castanea*). Incidentally, *lombardi* failed to intergrade in size with the typical form in one small area in the Bitter Root Mts., where their habitats were sharply demarcated, but both forms intergraded when their biotic conditions also did.

References: Listed in 1961, Naut. *74:* 142-149, to *75:* 145.

A NEW ENDODONTID LAND SNAIL FROM GUATEMALA

By FRED G. THOMPSON
Department of Zoology, University of Miami

During February through May, 1956, Paul F. Basch assembled a collection of inland mollusks from northeastern Guatemala. The major portion of this collection has already been reported (Basch, 1959). During the identification of the material upon which Basch based his report, several problematic species were put aside for future examination by me. These problematic species were collected in areas other than Tikal National Park, and did not pertain to his study. One of the more noteworthy of these species is a new endodontid snail, which is described below, and which I have the pleasure of naming after its collector: PUNCTUM BASCHI new species.

Spire moderately elevated, conical; surface satiny; color reddish brown with light tan flammulations which are 2-5 ribs wide; 6 flammulae present on body whorl, 5 on penultimate whorl, flammulae indistinct on earlier whorls; whorls 5¾, closely coiled, shouldered, slowly increasing in size; whorls of spire nearly flat-sided; body whorl rounded, slightly flattened below; embryonic whorls 1⅝, hyaline, glassy, colorless, smooth; remaining whorls crossed by moderately strong, regularly spaced retractile radial ribs, which abruptly appear immediately after the embryonic whorls; ribs strongest near the upper suture; ribs on earlier whorls stronger and more widely spaced than ribs on later whorls; 74 ribs on body whorl, about 0.1 mm. apart and about 1/7 the width of their intervals near the upper suture, continuous into the umbilicus, becoming finer on base of body whorl, and again becoming strong in umbilicus; finer sculpture consisting of 5-15 fine radial striations between each pair of ribs; striations equally spaced and crossed by similarly spaced, incised spiral striations which are continuous across the ribs and become much finer on the ribs. The radial and spiral striations give the surface of the whorls a fine, regular, checkered appearance which is readily seen under high magnification (x 100). Striations most distinct on umbilical surface of whorls; umbilicus 1/4 major diameter, open to embryonic whorls; body whorl becoming slightly more basal than earlier whorls, tending to constrict the umbilicus; suture deeply impressed, descending slightly to the aperture, which is broadly ovate-lunate; colmellar margin of aperture reflected; parietal callus thick, replacing ribs of penultimate whorl.

Measurements of the holotype: major diameter, 3.96 mm.;

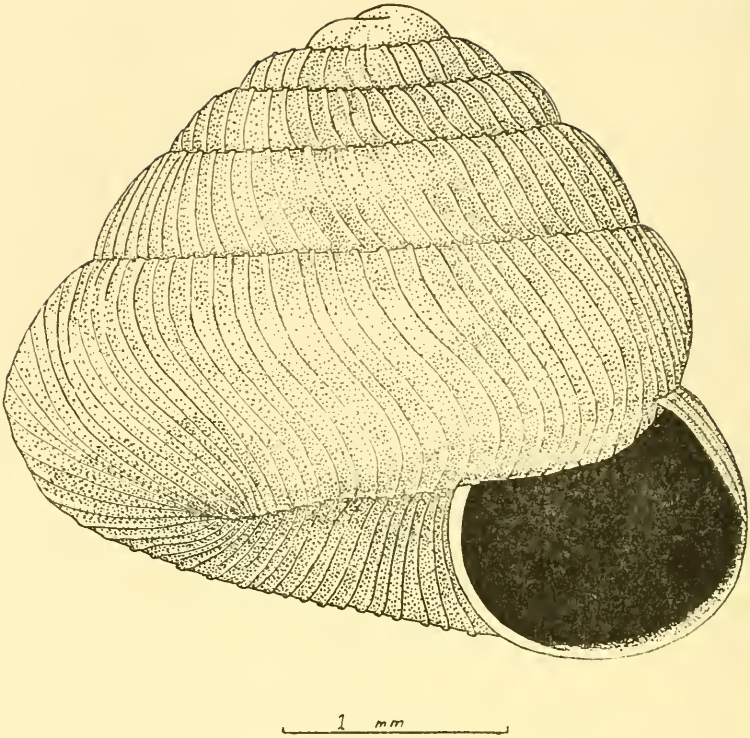


Fig. 1. *Punctum baschi* Thompson, type shell.

minor diameter 3.63 mm.; height, 3.58 mm.; diameter of umbilicus, 0.99 mm.; diameter of aperture, 1.54 mm.; height of aperture, 1.38 mm.; 5¾ whorls.

Measurements of one paratype: major diameter, 3.85 mm.; minor diameter, 3.47 mm.; height, 3.03 mm.; diameter of umbilicus, 1.0 mm.; diameter of aperture, 1.54 mm.; height of aperture, 1.43 mm.; 5½ whorls.

Holotype: UMMZ. 206682; Coban-Sebol road, 55 miles northeast of Coban, Guatemala; collected by Paul F. Basch, May 6, 1956. Paratypes: UMMZ. 206683 (2) ; same data as the holotype.

This species is provisionally assigned to the genus *Punctum* because of the similarity of its sculpture to that of species of the section *Toltecia* Pilsbry, 1926 (Baker, 1927). *P. baschi* most closely resembles *P. coloba* (Pilsbry, 1894) and *P. textilis* (Pilsbry, 1920), which are also of uncertain generic affinities. It is readily distinguished from these two species by its larger size,

shape, larger umbilicus and its flammulate color pattern. *P. coloba* is about 1.3 mm. high, and 2.0 mm. wide *P. textilis* is about 1.95 mm. high, and 1.95 mm. wide. In both species, the umbilicus is about 1/5 the diameter of the shell, and the shell is unicolor.

References

Baker, H. B. 1927. *Proc. Acad. Nat. Sci. Phila.*, 79: 223-246.
Basch, P. F. 1959. *Occ. Pap. Mus. Zool. Univ. Mich.*, (612): 1-15.
Pilsbry, H. A. 1894. *Proc. Acad. Nat. Sci. Phila.*, 46: 304.
—— 1920. *Ibid.*, 73: 195-202.
—— 1926. Ibid. 78: 57-126.

LOCALITIES FOR NEW HAMPSHIRE LAND MOLLUSKS

By LOWELL L. GETZ
Museum of Zoology, University of Michigan

There are few published locality records for terrestrial mollusks in New Hampshire. F. C. Baker (1942) summarized the records published up to that time. A check of the literature reveals no further records for the land snails of this state.

During the month of July, 1960, I spent several days collecting mollusks in the White Mountains of New Hampshire. Material was obtained from 16 localities encompassing most of the mountain range. All collections were made from under the logs and debris on the ground near the highway or in state and national parks or campsites. In all 23 species were obtained, 4 of which (*Haplotrema concavum, Vertigo gouldi, Punctum minutissimum* and *Arion subfuscus*) appear to be new state records. Two others, *Striatura milium,* and *Euconulus chersinus* have been listed as "rare" by Baker (op. cit.). In view of the paucity of information concerning the mollusks of New Hampshire these locality records are made available.

I wish to thank Drs. John B. Burch and Henry van der Schalie for assisting in the determinations. I wish also to thank Dr. Co. O. van Regteren Altena of the Rijksmuseum van Natuurlijke Historie, Leiden, Netherlands for making the identifications of the *Arion subfuscus.* The specimens have all been deposited in the collections of the mollusk division of the University of Michigan Museum of Zoology (except for portions of some of the lots of slugs, which have been sent to the Rijksmuseum van

Natuurlijke Historie, Leiden, Netherlands).

Triodopsis albolabris (Say).—Grafton Co.: 5 miles west Waterville; Carroll Co: 1 mile north Pequaket.

Mesodon thyroides (Say).—Coos Co.: 6 miles northeast Bretton Woods.

Stenotrema sp. (Say).—Grafton Co.: 5 miles West Campton.

Haplotrema concavum (Say).—Grafton Co.: 3 miles west Bretton Woods. Only a single specimen of this species was obtained.

Retinella cf. *electrina* (Gould).—Grafton Co.: 9 miles northeast Warren, 4 miles south Waterville, 2 miles northeast Campton, 3 miles west Bretton Woods, 6 miles southeast Franconia; Carroll Co.: 16 miles south Gorham, 6 miles south Bretton Woods.

Retinella rhoadsi (Pilsbry).—Carroll Co.: 1 mile north Pequaket; Coos Co.: 6 miles south Gorham.

Euconulus fulvus (Müller).—Grafton Co.: 3 miles southeast Haverhill, 2 miles northeast Campton, 3 miles west Bretton Woods; Carroll Co.: 6 miles south Bretton Woods, 1 mile north Pequaket.

Euconulus chersinus (Say).—Grafton Co.: 2 miles northeast Campton, 4 miles south Waterville, 9 miles northeast Warren; Coos Co.: 6 miles northeast Bretton Woods.

This species apparently is rare; only one specimen was obtained at each of the four localities.

Striatura exigua (Stimpson).—Grafton Co.: 5 miles west West Campton, 2 miles northeast Campton, 3 miles west Bretton Woods, 4 miles south Waterville, 9 miles northeast Warren; Coos Co.: 6 miles northeast Bretton Woods.

Striatura milium Morse.—Grafton Co.: 4 miles south Waterville, 3 miles west Bretton Woods, 2 miles northeast Campton; Coos Co.: 6 miles south Gorham.

Zonitoides arboreus (Say).—Grafton Co.: 5 miles west Waterville, 5 miles west West Campton, 3 miles southeast East Haverhill, 2 miles northeast Campton, 6 miles southeast Franconia, 3 miles west Bretton Woods, 5 miles southwest Bartlett, 4 miles south Waterville, 9 miles northeast Warren, 8 miles northwest North Woodstock; Carroll Co.: 1 mile north Pequaket, 16 miles south Gorham, 6 miles south Bretton Woods, 1 mile north North Chatham, 6 miles south Bretton Woods; Coos Co.: 6 miles northeast Bretton Woods, 6 miles south Gorham.

Deroceras laeve (Müller).—Grafton Co.: 5 miles west West Campton, 2 miles northeast Campton, 6 miles southeast Franconia, 3 miles west Bretton Woods, 8 miles northwest North Woodstock; Carroll Co.: 1 mile north North Chatham; Coos Co.: 6 miles northeast Bretton Woods, 6 miles south Gorham.

Anguispira alternata (Say).—Grafton Co.: 9 miles northeast Warren.

Discus cronkhitei (Newcomb).—Grafton Co.: 5 miles west West Campton, 3 miles southeast East Haverhill, 2 miles northeast Campton, 6 miles southeast Franconia, 3 miles west Bretton Woods, 5 miles southwest Bartlett, 4 miles south Waterville, 9 miles northeast Warren, 8 miles northwest North Woodstock; Carroll Co.: 1 mile north Pequaket, 16 miles south Gorham, 6 miles south Bretton Woods; Coos Co.: 6 miles northeast Bretton Woods, 6 miles south Gorham.

All specimens belonged to the subspecies *catskillensis*.

Helicodiscus parallelus (Say).—Grafton Co.: 5 miles west Waterville, 3 miles southeast East Haverhill, 2 miles northeast Campton, 6 miles southeast Franconia, 5 miles southwest Bartlett, 8 miles northwest North Woodstock; Carroll Co.: 1 mile north Pequaket, 6 miles south Bretton Woods; Coos Co.: 6 miles south Gorman.

Punctum minutissimum (Lea).—Grafton Co.: 5 miles west Waterville, 3 miles southeast East Haverhill, 3 miles west Bretton Woods, 5 miles southwest Bartlett, 4 miles south Waterville.

Arion subfuscus (Drap).—Grafton Co.: 2 miles northeast Campton, 8 miles northwest North Woodstock; Carroll Co.: 1 mile north Pequaket; Coos Co.: 6 miles south Gorham.

Locally abundant, particularly around camp grounds; 44 specimens were obtained.

Philomycus carolinianus (Bosc).—Grafton Co.: 5 miles west Waterville, 3 miles southeast East Haverhill, 2 miles northeast Campton, 6 miles southeast Franconia, 3 miles west Bretton Woods, 4 miles south Waterville, 9 miles northeast Warren, 8 miles northwest North Woodstock; Carroll Co.: 16 miles south Gorham, 6 miles south Bretton Woods, 1 mile north North Chatham; Coos Co.: 6 miles northeast Bretton Woods.

Pallifera dorsalis (Binney).—Grafton Co.: 5 miles west Waterville, 5 miles west West Campton, 3 miles southeast East Haverhill, 2 miles northeast Campton, 6 miles southeast Franconia, 5 miles southwest Bartlett, 4 miles south Waterville, 9 miles northeast Warren, 8 miles northwest North Woodstock; Carroll Co.: 1 mile north Pequaket, 16 miles south Gorham, 6 miles south Bretton Woods, 1 mile north North Chatham; Coos Co.: 6 miles northeast Bretton Woods, 6 miles south Gorham.

Succinea ovalis (Say).—Grafton Co.: 6 miles southeast Franconia, 9 miles northeast Warren; Carroll Co.: 6 miles south Bretton Woods.

Strobilops labyrinthica (Say).—Grafton Co.: 5 miles west Waterville, 2 miles northeast Campton, 3 miles west Bretton

Woods, 4 miles south Waterville, 8 miles northwest North Woodstock; Carroll Co.: 1 mile north Pequaket, 6 miles south Bretton Woods, 1 mile north North Chatham; Coos Co.: 6 miles south Gorham.

Vertigo gouldi (Binney).—Grafton Co.: 5 miles west Waterville, 5 miles west West Campton. Apparently rare, only one specimen was obtained at each station.

Cionella lubrica (Müller).—Grafton Co.: 2 miles northeast Campton.

Reference

Baker, F. C. 1942. Land and fresh water Mollusca of New Hampshire. Amer. Midl. Nat. *27:* 74-85.

RADULAE OF NORTH AMERICAN FRESHWATER LIMPET SNAILS. III. FERRISSIA AND LAEVAPEX [1]

By PAUL F. BASCH
Department of Biology, Kansas State Teachers College, Emporia, Kansas

This is the third in a series of papers on the radulae of North American ancylid snails. These studies are intended to evaluate the radula as a taxonomic and phylogenetic indicator, particularly on the generic level, and not primarily to investigate the ontogeny or peculiarities of this organ in any specific instances.

Illustrations and counts of radular teeth of various American ancylids have been published several times by myself and others (Basch, 1959a, b; 1962a, b; Baker, 1928; Walker, 1923), but few pains have been taken in the past to validate the counts as taxonomic characters by checking more than a small number of similar specimens. The present paper is based upon a study of more than 200 radulae, prepared from animals collected in all parts of North America with the exception of arctic regions. Thanks are due to Dr. Henry van der Schalie of the University of Michigan Museum of Zoology and to Dr. R. Tucker Abbott of the Academy of Natural Sciences of Philadelphia for permission to utilize museum specimens from their collections. Approximately 65 slides were made from such dried specimens by a process outlined in the first paper of this series (Basch, 1962a).

[1] This study was made possible through a grant (G-14125) from the National Science Foundation, to which I am greatly indebted. I am grateful to Mr. Jack Woodhead and Mr. Edward Garner for assistance in collecting specimens.

The remainder of the preparations were made from ancylid specimens collected at various times during the past 5 years, but principally during the summer of 1961, in which 9 weeks were devoted exclusively to collecting freshwater limpets. From my own collections, graded series of specimens could be selected from distinct populations with known locality and habitat data and preserved in fluid under uniform conditions. Radulae from these preserved specimens were made by the cloroxlactophenol method (Basch, 1961). In addition to the radulae from museum specimens, and those from my own field collections, I have examined all the available ancylid radulae prepared by Rev. H. M. Gwatkin for Mr. Bryant Walker in the early 1900's, as maintained in the University of Michigan Museum of Zoology.

At first sight, the radulae of North American *Ferrissia* and *Laevapex* are rather monotonous. The laterals have about 3 major and several minor cusps, extremely variable from one individual to another. In *Ferrissia* these cusps are plate-like and broadly attached at the bases, while those of *Laevapex* are more sharply demarcated. Marginal teeth are straight, at right angles to the long axis of the ribbon, possessing a subsymmetrical array of needle-like cusps which are more evident in *Laevapex*. The centrals are normally bicuspid, but highly asymmetrical centrals are found occasionally in an individual selected at random from a population whose other members are normal (see Fig. 1,H). An irregularity of this kind is repeated serially along the entire ribbon. With the relatively small samples studied, a meaningful estimate of the incidence of this abnormality cannot be prepared, but it appears to be common enough to cast doubt upon the validity of using the symmetrical or asymmetrical centrals as a taxonomic character, as has been done with the questionable genus *Gundlachia* (see Connolly, 1939, Wurtz, 1951).

In *Ferrissia* and *Laevapex,* the number of transverse rows of teeth and the number of teeth per row both increase directly with shell size (see Fig. 2). Thus the radular formula is of little use without an indication of the size of the shell from which the radula was prepared. Such variation with size has been pointed out for Stylommatophora by Sterki (1893) and Boycott (1914), and for the limnophile *Lymnaea stagnalis* by Carriker (1943); and may be a general feature of the pulmonates. The size of

individual teeth is difficult to measure with precision, but appears to remain relatively static or to increase slightly with increasing shell size. In prosobranchs *(Viviparus)* the number of teeth per row is constant throughout life, but their size increases with the growing snail (Howe, 1930).

If care is taken with the preparation, measuring, and counting of the teeth, it is possible to distinguish *Ferrissia* from *Laevapex* by radular characters alone. For animals with shells of the same length, the teeth of *Laevapex* are smaller and more numerous than those of *Ferrissia.* In particular, for shells between 3 and 6 millimeters long (the most common range), *Laevapex* will usually have more than 20 teeth on either side of the central, and *Ferrissia* fewer than 20. The distance between successive rows in *Laevapex* rarely exceeds 8 microns, while it is usually more than 10 microns in the larger species of *Ferrissia,* such as *F. rivularis.* Spot checks on these characters have been made on radulae from approximately 40 localities in various parts of the United States, and I feel confident that they are generally valid and applicable. Although very young *Laevapex* may have radular counts and measurements similar to those of the tiny septate or non-septate *Ferrissia* of the *fragilis* group, there is no possibility of confusing the two groups because of the great differences in the shells.

The radular teeth of both *Ferrissia* and *Laevapex* are extremely similar to those of many planorbid snails (cf. Baker, 1945; Hubendick, 1955). Since such a similarity probably would not arise fortuitously, and on the basis of other anatomical features, a phylogenetic relationship is suggested, in which the planorbids are undoubtedly ancestral. *Ferrissia* and *Laevapex* may be derived from the Planorbidae either (1) through a common proto-ancylid ancestor evolved from a single planorbid stock, or (2) independently, from different groups of planorbids. Many similarities between the two genera under discussion (e.g., radula, kidney, digestive tract, position of anus, shell musculature) argue against separate planorbid ancestors and in favor of a common proto-ancylid type. Anatomical evidence (particularly the male genitalia) suggests that *Laevapex* has departed further from such a type than has *Ferrissia,* and the far wider geographic distribution of *Ferrissia* tends to support such a conclusion. The group from which the proto-ancylid may have developed appears

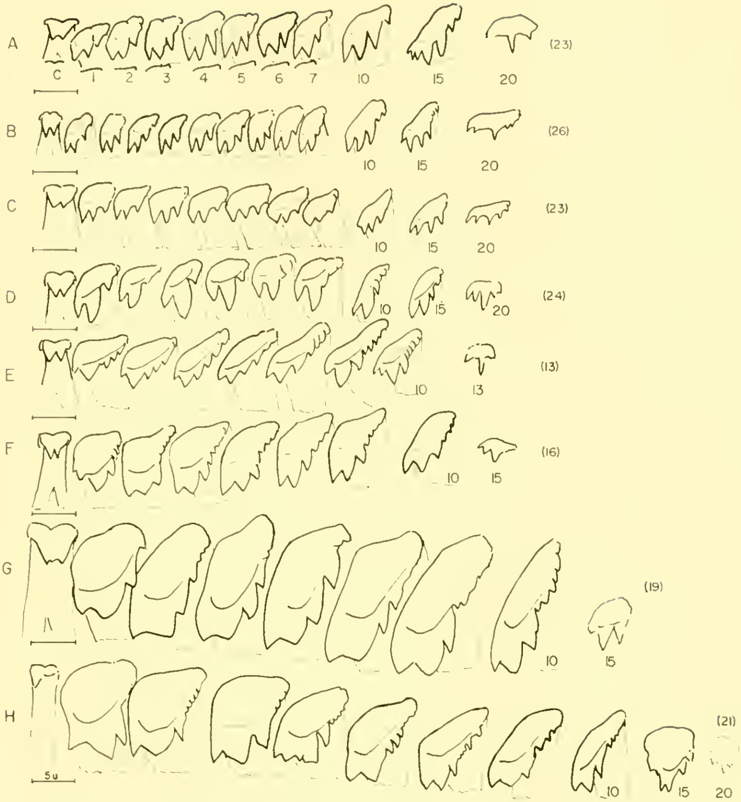


Figure 1. Outline drawings of radular teeth of *Laevapex* and *Ferrissia* all drawn to the same scale with the aid of a camera lucida. Magnification at ocular, 1250X; on tabletop, 3100X. For each ribbon the central tooth is shown at the left, plus at least the first 6 laterals. The numbers of the other teeth are indicated. The figure in parentheses at the right is the total count of teeth from the first lateral to the edge of the ribbon. Scale line below central, 5 microns. All specimens collected and prepared by the author.

A. *Laevapex fuscus*, Huron River at Ann Arbor, Washtenaw Co., Mich. Shell length. 5.2 mm. B. *L. fuscus*, north pond, Sapelo Island, McIntosh Co., Georgia. Shell length, 5.6 mm. C. *L. fuscus*, lake in Melrose. Alachua Co., Florida. Shell length, 5.1 mm. D. *L. hemisphaericus*, South Fourche River near Hollis, Perry Co., Arkansas. Shell length. 5.0 mm. E. *Ferrissia fragilis*, marsh near Sunbury, Gates Co., North Carolina. Shell length. 2.9 mm. F. *F. rivularis,* creek near Butte Falls, Jackson Co., Oregon. Shell length, 4.2 mm. G. *F. rivularis*, Yakima River at Ellensburg, Kittitas Co., Washington. Shell length, 5.7 mm. H. *F. rivularis*, stream near Yellow Springs, Greene Co., Ohio. Shell length, 6.2 mm.

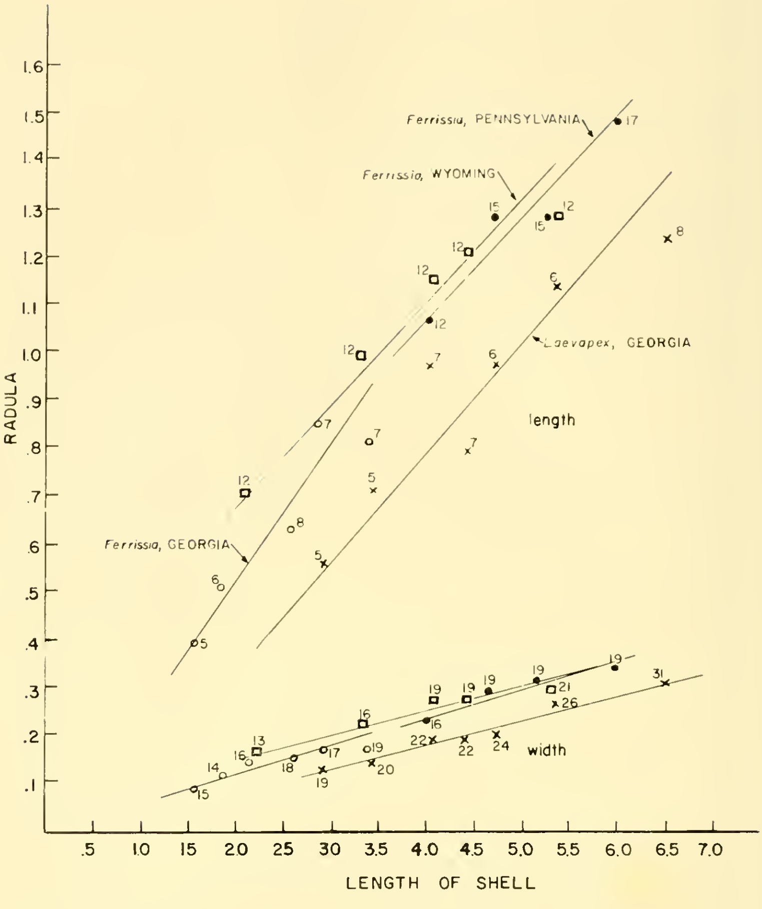


Figure 2. Analysis of the radular characteristics of 4 populations of ancylids. All scale values in millimeters. The upper group of lines indicates the relationship between length of shell and length of the radula; the small number at each point shows the distance, in microns, between successive rows of teeth. The lower group of lines indicates the relationship between length of shell and width of the radula. The small number at each point here shows the number of teeth between the central and the edge of the radula. Note that the radula of *Laevapex* is proportionately smaller than that of *Ferrissia*, and that teeth are smaller and more numerous.

Crosses, *Laevapex fuscus* from Sapelo Island, McIntosh Co., Georgia. Open circles, *Ferrissia fragilis* from ditch, Wayne, Co., Georgia. Closed circles, *Ferrissia rivularis* from Canoe Creek, Blair Co., Pennsylvania. Squares, *Ferrissia rivularis* from Little Laramie River, Albany Co., Wyoming. Lines estimated for best fit.

to fall into the *Planorbis* or *Segmentina* tribes of Hubendick's subfamily Planorbinae.

LITERATURE CITED

Baker, Frank C. 1928. The fresh water Mollusca of Wisconsin. Part I. Gastropoda. Wisconsin Geol. and Nat. Hist. Surv. Bull. 70: 507. Pp.

Basch, Paul F. 1959a. The anatomy of Laevapex fuscus, a fresh-water limpet (Gastropoda:Pulmonata). Misc. Publ. Mus. Zool. Univ. Mich. 108: 1-56.

—— 1959b. Status of the genus Gundlachia (Pulmonata:Ancylidae). Occ. Pap. Mus. Zool. Univ. Mich. 602: 1-9.

—— 1961. Turtox News 39 (1): 46.

—— 1962a. Nautilus *75:* 97-101.

—— 1962b. Nautilus *75:* 141-149.

Boycott, A. E. 1914. Jour. of Conchology. *14:* 214:220. (first part).

Carriker, M. R. 1943. Naut. *57* (2): 52-59.

Connolly, M. 1939. A monographic study of South African non-marine Mollusca. Annals S. Afr. Museum *33:* 660 Pp.

Howe, Sam W. 1930. Nautilus *44* (2): 53-66.

Hubendick, Bengt. 1955 Trans. Zool. Soc. London *28* (6): 453-

Sterki, Victor. 1893. Proc. Acad. Nat. Sci. Phila. *46:* 388-440.

Walker, Bryant. 1923. The Ancylidae of South Africa. London. 542.

Privately Printed. 62 Pp.

Wurtz, C. B. 1951. Nautilus 64 (4): 123-131.

MAXWELL SMITH
1888-1961

Maxwell Smith was born March 23rd, 1888, at South Orange, New Jersey. He was the only child of Maxwell Smith, senior, a civil engineer of New York city, and Annie Lum Keep, a remotely related cousin of Prof. Josiah Keep of Mills College, California.

After the death of his father when Maxwell was 15 years old, he and his mother came to La Jolla, California, to spend the winter, and here he became so devoted to the study of conchology that their visit stretched out to two years. Upon their return to New York, he worked for some time in the American Museum of Natural History assisting Dr. Gratacap, after which he and his mother spent several years gathering shells around the Mediterranean Basin and elsewhere in Europe. On returning to

America, they settled down in New York, but, since they thought that the Empire State did not afford sufficient opportunity for activity in the field of conchology, they migrated to Florida, where they remained until the death of Mrs. Smith in 1948, after which Maxwell again resumed his peregrinations in search of the elusive snail, over Canada, Cuba, Mexico, Jamaica, Costa Rica and Panama.

Although he remained a citizen and resident of Florida, he eventually acquired a summer home in Asheville, North Carolina, where he spent part of every year, and there death called him September 12th, 1961, as the result of a cerebral haemorrhage, which followed several unsuccessful operations for removal of a carcinoma.

Conchology was not Maxwell's only interest. Before taking up this science, he had become an enthusiastic and skillful photographer, and he also had an excellent stamp collection, the nucleus of which he had inherited from his father. Later he took up tape recording, but the Mollusca always held a prior lien on his attention over his other interests. He was the author of several books: East Coast Marine Shells; Catalog of Rock Shells; World Wide Sea Shells; Review of the Volutidae; Tritons, Harps and Helmets; and Universal Shells, of which only one of 3 projected volumes has appeared.

A few years ago, the University of Alabama conferred upon him the honorary degree of Doctor of Science, and in appreciation of this deserved compliment, Dr. Smith arranged for his collection and his library to become the property of that institution.

He was a past president of the American Malacological Union, and held life memberships in the British Conchological Society and the Malacological Society of London. Especially among the members of these, he had many friends, by whom he will be missed sadly. — Joshua L. Baily, Jr.

NOTES AND NEWS

Dates of the Nautilus.—Vol. 75, no. 1, pp. 1-42, pls. 1-5, was mailed July 3, 1961. No. 2, pp. 43-86 (pl. 6), Oct. 4, 1961. No. 3, pp. 87-126, pls. 7-10, Jan. 9, 1962. No. 4, pp. 127-166 + title

page and indexes, pls. 11-16, April 9, 1962. The cost of printing vol. 75 exceeded the income from subscriptions by over $300, so the next will return to the traditional 144 pp.— H. B. B.

CORRECTION.—The scale of fig. 1, p. 163, in the last (April) number, although marked 1 cm., is actually 1/3 cm. in length.— JERRY DONOHUE.

EXTENSION OF THE RANGE of *Corbicula fluminea* within the Ohio Drainage.—During the first two weeks of September, 1961, extensive collections were made along 20 miles of the Green River in Kentucky. * This area extended from below Central City, Kentucky, to above Paradise, Kentucky. On Corps of Engineers' navigational charts this is from approximately mile 82 to mile 102. These collections revealed the presence of large numbers of *Corbicula fluminea*.

Information concerning the occurrence of this so-called "Asiatic clam" in the Tennessee and Cumberland drainages has been presented by Sinclair and Isom (1961). However, no reports have been made of its occurrence in the Ohio drainage above the Cumberland River. This report of its presence 100 miles upstream from the confluence of the Green with the Ohio thus represents a considerable extension of its range.

These Green River collections yielded thousands of individuals ranging up to a maximum size (length) of 27 mm. No preponderance of any one size class was observed. The highest per unit area concentration of individuals was observed in those areas having a sand-mud substrate; substrates of firmer nature yielded accordingly fewer individuals in apparent direct proportion. Even those dredge samples taken from the dredged river channel, which is bedded with firm clay-sand, contained some individuals. Specimens were also collected from under rocks, from between boulders, and lodged in crevices in wood. Substrate thus does not appear to be a limiting factor in the distribution of this species.

To determine the extent of upstream invasion, several collections were made from the Green River in the vicinity of Mam-

* These collections were made under the auspices of the Limnology Department, The Academy of Natural Sciences of Philadelphia, Philadelphia, Pennsylvania.

moth Cave National Park. These collections produced no specimens of *Corbicula*. In attempting to understand the rapid dispersal of this species, one is immediately led to speculate on the possible role being played by commercial shipping. On the Green River, there is no commercial traffic above Paradise, Kentucky. The areas of invasion on the Tennessee River and Cumberland River are open to commercial navigation. This species thus seems to be spreading rapidly throughout the navigable waterways of the Ohio drainage; I have received reliable information that *Corbicula* now occurs as far upstream on the Tennessee River as Knoxville. One wonders whether or not it has yet invaded other tributaries of the Ohio River such as the Wabash. Apparently little ecological resistance exists to prevent complete dominance of available mussel habitats by this species.—John M. Bates.

Literature cited

Sinclair, Ralph M. and Billy G. Isom. 1961. A Preliminary Report on the Introduced Asiatic Clam Corbicula in Tennessee. Tennessee Stream Pollution Control Board, Tennessee Department of Public Health. pp. 1-33.

Additional Wisconsin records of *Viviparus contectoides*.—Previous records consist of a single "bone" from a stream near Milwaukee (Baker, 1928, Mollusca of Wisconsin), and a report of their living in abundance in Knight Lake, a small lake at the upper end of the Chain o'Lakes, Waupaca Co. (Washburn, 1957, Naut. *71* (2) :iii).

On June 24, 1961, a series of *V. contectoides* was collected from Sunset Lake, near Waupaca, Waupaca Co. by Miss Joanne L. Evenson. On August 12, 1961, Miss Evenson found this species at Lake Geneva, Walworth Co. Shells and dissections of these specimens are in our museum (Nos. 107266; 110451). Wisconsin collectors are urged to look for *contectoides* in other localities. A revision of the North American viviparids is being prepared by Dr. William J. Clench, to which I look forward with keen interest.—Ernest J. Roscoe, Division of Lower Invertebrates, Chicago Natural History Museum.

Sinistral Polygyridae—A sinistral specimen of *Triodopsis fraudulenta vulgata* Pilsbry, a normally dextral snail, was found

among unsorted material in the Phil L. Marsh collection, now being incorporated into the Museum of Zoology, University of Michigan. The shell was mature, in good condition, had the usual aperture and 5 whorls; however, it was slightly more depressed than the usual form. The diameter was 13.8 mm. and the height 6.2 mm. This specimen was collected along the Huron River near Wagner Road, Washtenaw County, Michigan (no date) and now has the UMMZ. catalog number 210162. Another abnormal, i.e. scalariform, though dextral, specimen of *T. fraudulenta vulgata* has been previously reported by Solem (1953, Naut. 67: 18-20).

A sinistral example of *Triodopsis albolabris* was also contained in the above mentioned Marsh collection. This specimen was mature, although badly broken and apparently dead when collected. It was collected at Waters Road, 1/4 mile West of Wagner Road, Washtenaw County, Michigan (UMMZ. 210163).

Reversely coiled snails have been recorded from a great many groups. Among the Polygyridae this condition is unusual, but has been found in at least 10 species and 4 genera. Pilsbry, 1910, Land Mollusca of North America, Volume 1, Part 2, mentioned the occurrence of sinistrality in the following species: *Polygyra septemvolva* Say, *P. mooreana* (W. G. Binney), *Mesodon zaletus* (Binney), *M. inflectus* (Say), *Triodopsis albolabris* (Say), *T. multilineata* (Say), *T. hopetonensis* (Shuttleworth), *T. fosteri* (F. C. Baker) and *Allogona profunda* (Say). Baily (1942, Naut. *55:* 102) has reported a sinistral specimen of *Polygyra cereolus* (Muhlfeld) and Fluck (1943, Naut. *56:* 105) also noted two left coiled examples of *Mesodon zaletus* (Binney).—Norman J. Reigle, University of Michigan Museum of Zoology.

Nesovitrea (?) harimensis.—In every shell of the type lot (A.N.S.P. 78824; marked "=*doenitzii*" by Pilsbry) of *Vitrea harimensis* Pilsbry, 1900 (24):384, from Japan, the umbilicus is visibly open, as in most Zonitinae. Also, from the thickness of its parietal callus, the type shell (1.8 x 3.5 mm. with 3½ whorls) may have come from an adult animal. Incidentally, the radular figure given by Habe, 1945, Venus *14*:24, fig. C, for "*Pseudhelicarion (Urazirochlamys) doenitzi*" looks like that of a zonitine. In contrast, most of the shells of similar size, in the A.N.S.P.

lots labeled *doenitzi,* exhibit the shelly film, which occludes the umbilicus in so many euconulids (and Helixarioninae). Even larger examples, similar in dimensions to those (3.5 x 7 mm. with 5½ whorls) given for *Hyalina doenitzii* Reinhardt, 1877, Sitz. Ges. nat. Fr. Berlin:68; Jahrb. deutsch. malak. Ges. *4:*316, pl.10, figs. 3, often retain remnants of this occlusion. Author's examples of the last have not been seen.—H. Burrington Baker.

PUBLICATIONS RECEIVED, 1960

Pages in *italics* include new taxons

Burch, John B. Chromosome numbers of schistosome vector snails. Zeitschr. Tropenmediz. Parasit. *11:*449-452, 8 figs. Chromosome morphology of aquatic pulmonate snails (Mollusca: Pulmonata). Trans. Amer. Microscop. Soc. *79:*451-461, 13 figs. Chromosome studies of aquatic pulmonate snails. Nucleus *3:*177-208, 162 figs. Burch, P. F. Basch & L. L. Bush. Chromosome numbers in ancylid snails. Rev. Portug. Biol. Geral *2:*199-204, pl. 1.

Carriker, Melbourne R. Thurlow Christian Nelson, marine biologist. Science *132:*1875-1876, portrait.

Habe, Tadashige. New species of molluscs from the Amakusa Marine Biological Laboratory, Reihoku-Cho, Amakusa, Kumamoto Pref., Japan. Eleven new bivalves from Tanabe Bay, Wakayama Presf., Japan. Publ. Seto. Mar. Biol. *8: 281-288,* 24 figs.; *289-298,* 5 figs. Egg masses and egg capsules of some Japanase marine prosobranchiate gastropod. Bul. Mar. Biol. Sta. Asamushi Tohoku University *10:*121-126, 11 figs.

Merrill, Arthur S. & John B. Burch. Hermaphroditism in the sea scallop, *Placopecten magellanicus* (Gmelin). Biol. Bul. *119:* 197-201, 2 figs.

1961

Benthem Jutting, W. S. S. van. The Malayan Streptaxidae genera *Huttonella* and *Sinoennea.* Additional new species and new localities of the family Vertiginidae and the genera *Oophana* and *Opisthostoma* from Malaya. Bul. Raffles Mus. no. *26:1-32,* 7 pls.; *33-48,* 7 pls.

Branson, Branley A. The recent Gastropoda of Oklahoma, III. Proc. Okla. Acad. Sci. *41:*45-69, pls. 1 & 2. Notes on some gastropods from northern Louisiana. Proc. La. Acad. Sci. *24:*24-30.

Carriker, Melbourne Romaine. Comparative functional morphology of boring mechanisms in gastropods. Amer. Zoologist *1:*263-266, fig. 1. Interrelation of functional morphology, behavior, and autecology in early stages of the bivalve *Mercenaria*

THE NAUTILUS

Vol. 76 October, 1962 No. 2

CARIBBEAN MARINE SHELLS

By THOMAS L. MCGINTY

Florida's population expansion appears to have stimulated interest in shell collecting, particularly in south Florida and that lovely chain of picturesque islands extending to the southeast, an area abounding in historic localities from which so many of our western Atlantic types were collected and described by d'Orbigny, Reeve, Sowerby, C. B. Adams, Mörch and others. A few notes and observations plus three hitherto undescribed species from this general Caribbean area are hereby brought to attention, together with a brief review of the genus *Bursa* as presently known from the western Atlantic. Of particular interest to Florida collectors is the fact that all species in this group may be taken in south Florida, either from the shallows or the deeper waters off shore.

Genus *BURSA* Röding, 1798

Bursa finlayi, new species. Plate 3, fig. 2.

Shell rather large, thin but strong, evenly rounded whorls, relatively slender spire and pronounced sharp heavy nodules at the shoulder. Whorls 7, plus a white naticoid nucleus of about 4 whorls. Early nuclear whorls sculptured with fine axial riblets and 3 spiral threads, the riblets disappearing first, then the spiral threads, leaving the final ⅓ whorl smooth. Shell sculpture consists of beads and nodules arranged in spiral rows, the shoulder bearing a row of heavy pointed nodules with a second and lesser row just below at the periphery. Rows of beads and sharp nodules vary in size, the rows of small and heavy beads often alternate. Entire surface of shell covered with very fine cancellate sculpture. Varices unevenly spaced, not in line, about ⅔ of a whorl apart. Color straw, with diffused markings of light brown. Aperture ovate, with a flush of delicate orchid within, and the parietal wall has some brown between many white folds.

Holotype: Length 43 mm., width 24 mm., U. S. Nat. Mus. no. 634570, dredged 215° off Sombrero Key Light, Florida Keys, on the rocky Pourtales Plateau, 115 fathoms, McGinty, leg., "Triton" Station 615, July 8, 1951. Three paratypes in the McGinty collection from the "Triton" dredging are from off Sand Key Light, Key West, Florida, 70-75 fathoms.

Figure 1 and 1a (nucleus).—Cuban paratype: Length 84.7 mm., width 42 mm., in the McGinty collection, taken by Mr. Finlay from fish trap, rocky bottom, 100-110 fathoms, at Gibara, Oriente Province, Cuba, September 1958. Paratypes from the Gibara station, also from Matanzas Bay, Cuba, 100-125 fathoms, all from fish traps with hermit crabs, are in the collection of Mr. John Finlay, and through his generosity a Cuban paratype has been donated to the USNM.

Remarks.—This new species may best be compared with *Bursa tenuisculpta* Dautzenberg and Fischer, 1906, originally described from Madeira and the Azores, the only Atlantic species to be placed in the rather artificial subgenus *Tutufa* Jousseaume, 1881, with *Bursa finlayi* now to be added. *Bursa finlayi* appears to live in slightly deeper water, and the shell is larger and more spinose than *B. tenuisculpta.*

This attractive large *Bursa* is named for John Finlay, whose active research has added greatly to our knowledge of Cuban shells.

Bursa tenuisculpta, (figure 3), dredged on the rocky Pourtales Plateau, off Sombrero Key Light, Florida Keys, 115 fathoms, McGinty, leg., "Triton," June 14, 1950. (Figured for comparison) Size: Length 60 mm., width 32.5 mm.

The nuclear shell is almost always eroded on adult specimens of *B. tenuisculpta,* but two young specimens, taken in the "Triton" dredgings off the Florida Keys, have perfect nuclear whorls showing the same delicate sculpture as *B. finlayi.* Both species have a nucleus of similar size, but with *B. tenuisculpta* nearly the entire last whorl is without sculpture, while on *B. finlayi* only about the last 1/3 whorl is smooth. I hope that the nucleus and operculum of the eastern Atlantic *B. tenuisculpta* may eventually be compared with this western Atlantic representative.

Figure 3a.—Concentric and corneus operculum with central nucleus from the live specimen of *Bursa tenuisculpta* shown in figure 3. Greatest diameter, 10.5 mm.

A brief review of the now known remaining members of the western Atlantic *Bursa* group follows:

Bursa thomae (Orbigny, 1842). Range from Palm Beach, Florida to Brazil. This reef loving species may be taken from very shallow water, under rocks and coral, or to a depth of about

40 fathoms. It may readily be identified by its lavender mouth and small size.

Bursa corrugata (Perry, 1811). The brown form of this species, with flattened outer lip, is figured beautifully in color on plate 9, figure "k", in Abbott's "American Seashells." I wish to extend its known range from Brazil to off Palm Beach, Florida, 75 fathoms, mud and broken shell, McGinty, leg., "Triton" Station 1242, August 1, 1953. Almost invariably this form, with the brown lip, is taken with a decollate spire. There is, however, another smaller variant of *B. corrugata,* with white lip, which occurs without decollation. This has been figured (September 1948) on the cover of Lyman's "Shell Notes," Vol. 2, No. 4. It is quite scarce, but 3 specimens have passed through my hands for identification, habitats as follows: reef off Ft. Lauderdale, Florida, 5 fathoms, (J. W. Donovan); reef off Key Largo, Florida, (C. J. Finlay); and from Varadero, Cuba, (H. H. Monroe).

Bursa cubaniana (Orbigny, 1842). Range from south Florida to the Caribbean, perhaps the best known in the group. The writer has observed a female of this species resting upon its rather large cup shaped egg case, late in spring, under rocks in very shallow water. I suspect that this position is retained until the tiny young are ready to be turned loose, as appears to be the case with our common *Cypraea zebra.* The female has a larger shell than the male, and the nucleus of *B. cubaniana* has delicate cancellate sculpture, as in *B. finlayi.*

Bursa spadicea (Montfort, 1810). Range from within Lake Worth, Florida, (Nautilus *54*:71) to Dutch Guiana, northern coast of South America. This is a flattened species, always scarce, with a delicate cancellate nucleus and ungulate operculum.

Genus *COLUBRARIA* Schumacker, 1817

COLUBRARIA MONROEI, new species. Plate 3, figs. 4 and 4a.

Shell small, slender, fusiform, rather thin, of about 5 whorls including the smooth bulbous nucleus of about 1½ whorls. Rounded varices, 3 per whorl, axially placed one below another. Surface delicately and beautifully sculptured with fine spiral threads and less distinct axial ribs, giving the surface a finely cancellate appearance. Aperture narrow, long, smooth within; outer lip thickened by last varix, the edge crenulate. Inner lip thin, only slightly raised, smooth within. Siphonal fasciole distinct, open, with a former siphonal fasciole visible from the face view. Color light straw to white.

Holotype: Length 7.2 mm., width 2.7 mm., USNM. no. 634571. The holotype and two paratypes were collected in fresh condition from beach drift at Varadero Beach, Cuba, by H. H. Monroe and a paratype is in his own collection, another in the McGinty collection.

Remarks.—It is curious that a new Caribbean *Colubraria* would appear at this late date, but *C. monroei* is quite distinct from the two well known species, *lanceolata* Menke and *obscura* Reeve, both from the same area. *C. monroei* may easily be identified by the alignment of the varices on successive whorls, and also by its much smaller size. This unusually attractive and beautifully sculptured *Colubraria* is named for Henry H. Monroe, whose extensive collecting in Cuba and the West Indies has brought together an outstanding collection from this area.

Genus *RISSOINA* Orbigny, 1840

RISSOINA SHEAFERI, new species. Plate 3, fig. 5.

Shell large for the genus, slender, strong, of about 11 whorls including the smooth, rounded nucleus of about 2 whorls. Beautifully sculptured with strong axial ribs and much weaker spirals, the spirals very weak between the ribs, but a faintly beaded sculpture developing where the spirals cross the ribs. Sutural channels weak, siphonal fasciole low and broad, outer lip thickened. Color white.

Holotype: Length 9.3 mm., width 3.8 mm., collected at Hastings Rocks, Barbados, in the USNM. no. 634572. Paratype collected at Colon, Caribbean Panama, by T. L. McGinty, April 5, 1953. Additional records: Almirante, Caribbean Panama, A. A. Olsson, collector, 1920; Christiansted Reef, St. Croix, Virgin Islands, Gordon Usticke, collector, October 1961, a fine large specimen, length about 13 mm.

Remarks.—This striking new *Rissoina* may be placed in the subgenus *Phosinella* Mörch, 1876. The sculpture is less reticulate than *cancellata* Philippi or *sagraiana* Orbigny, and the shell is larger than either, *R. sagraiana* being rather small, about 5 mm. This large and handsome *Rissoina* is named for Clinton W. Sheafer, whose many trips to the Caribbean have produced much valuable conchological material.

Genus *FUSILATIRUS* McGinty, 1955

FUSILATIRUS ERNESTI (Melville, 1910). Plate 3, fig. 6.

A specimen of this interesting little shell, with raised white spiral threads on the dark brown shell, was collected at Varadero, Cuba, by H. H. Monroe. Length 8.8. mm. (apex and part of

the siphonal canal lost), width 4 mm. It is shown in figure 6, in the hope that it may become better known. I have also examined a second, even better specimen, collected by Gordon Usticke at Maid Island, Antigua. This specimen, about 10 mm. in length, has low, wide, rounded ribs and the white spirals are quite striking against the very dark brown of the shell. These attractive little shells appear to belong in the genus *Fusilatirus,* but a positive determination may not be made without a study of the radula. In 1941, in an excellent paper, my friend Dr. Fritz Haas described a new and very colorful shell from Yucatan, Mexico, as *Latirus festivus.* This species also appears to belong in the genus *Fusilatirus.* A reproduction of Melville's original figure of *Latirus ernesti* is shown in this paper.

Genus *ATYS* Montfort, 1810

ATYS CARIBAEA (Orbigny, 1841).

Considerable confusion has existed for many years in the correct identification of this attractive, fairly common, small, thin, white bulla-like shell. As a result of a recent examination of Orbigny's types in the British Museum, the spiral lines are now known to be confined to the ends of the shell, and the center is entirely smooth. Although the outline of Orbigny's original figure compares favorably with the types of *caribaea* examined, the artist wrongly covered the center of the shell with spiral lines, an error which has confused identification for many years. I find no way to separate *Atys guildingi* Sowerby, 1869, or *Atys riiseana* Mörch, 1875, and believe them to be synonymous. With a remarkable depth range, *caribaea* has been found living in Lake Worth, Florida, in sand and grass in 2 feet of water, and at over 100 fathoms, mud, where it was taken alive in the "Triton" dredging off Palm Beach, Florida. The figure in Abbott's "American Seashells," page 278, fig. 59c, is a good representation of an average specimen of *caribaea.* Although Dall's *Atys sandersoni* came from the great depth of 805 fathoms, a further examination of his type may prove that this is also a synonym of *caribaea.*

There is another more slender *Atys* which lives with *caribaea,* but at a reduced depth range. This *Atys,* with spiral lines which usually cover the entire surface, was identified as *Atys sharpi* Vanatta by Dr. Pilsbry some years ago. Usticke's *Atys lineata,* which lives in shallow water with both *caribaea* and *sharpi,* is probably a subspecies of *sharpi.*

Genus *SOLARIELLA* Wood, 1842

SOLARIELLA CARVALHOI Lopes and Cardoso, 1958.

This little shell, about 6 mm., described from Sao Paulo, Brazil, shallow water, has an outline much like *S. peramabilis* from the Pacific coast of North America, but differs by having 3 spiral keels above the flat shoulder. It now has been dredged alive from shallow water off Varadero, Cuba, by John Finlay (C. J. Finlay). It also has been taken on the nearby beach by C. J. Finlay, H. H. Monroe and J. A. Weber. I believe these are the first records for this species north of Brazil, greatly extending its known range.

SPAWNING AND EARLY LIFE HISTORY OF HALIOTIS RUFESCENS SWAINSON

BY JOHN G. CARLISLE, JR.

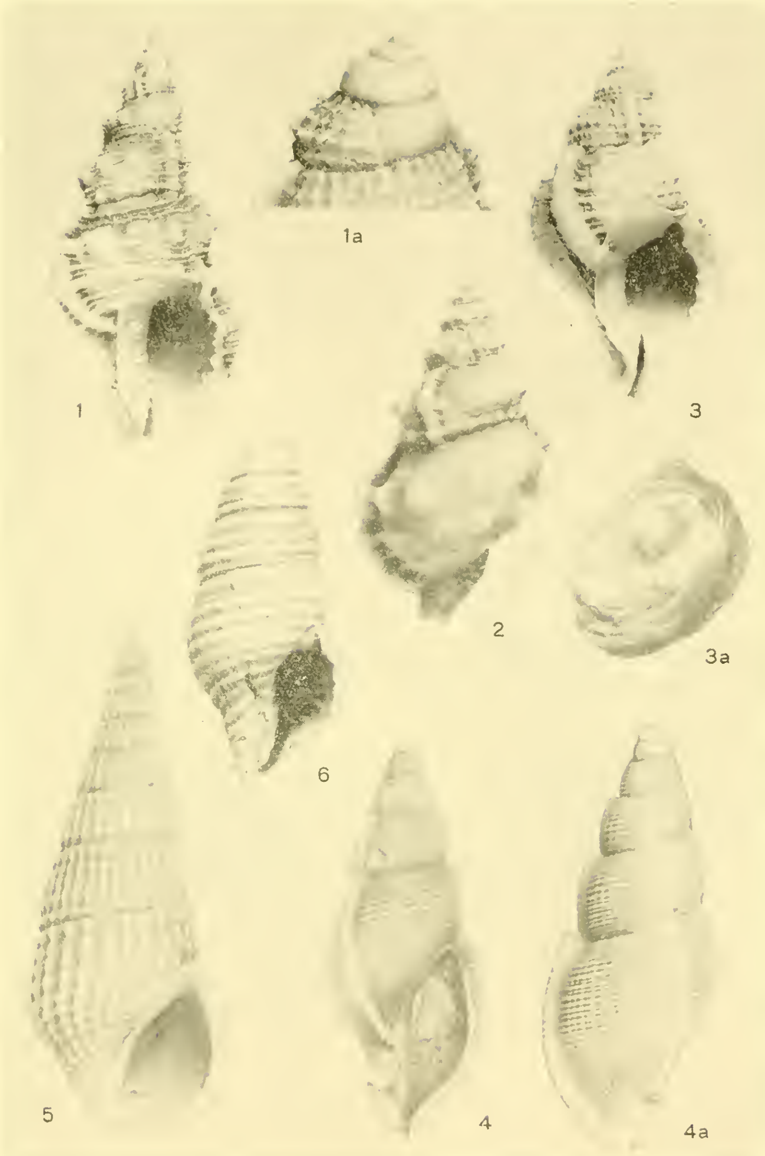
The present paper, much briefer than initially intended, was originally planned as a master's thesis upon completion of studies begun in 1940 at Stanford University's Hopkins Marine Station. Because of ensuing interruptions, including military service during World War 2, I have not been able to complete the studies. The information at hand, however, is deemed of interest because of the complete lack of knowledge of the larval life in nature of any of the species of *Haliotis* from the west coast of North America.

Data on the larval development of Japanese species of *Haliotis* were published in 1952 (Ino, 1952) and some of his information has been intergraded into this paper to make it more complete.

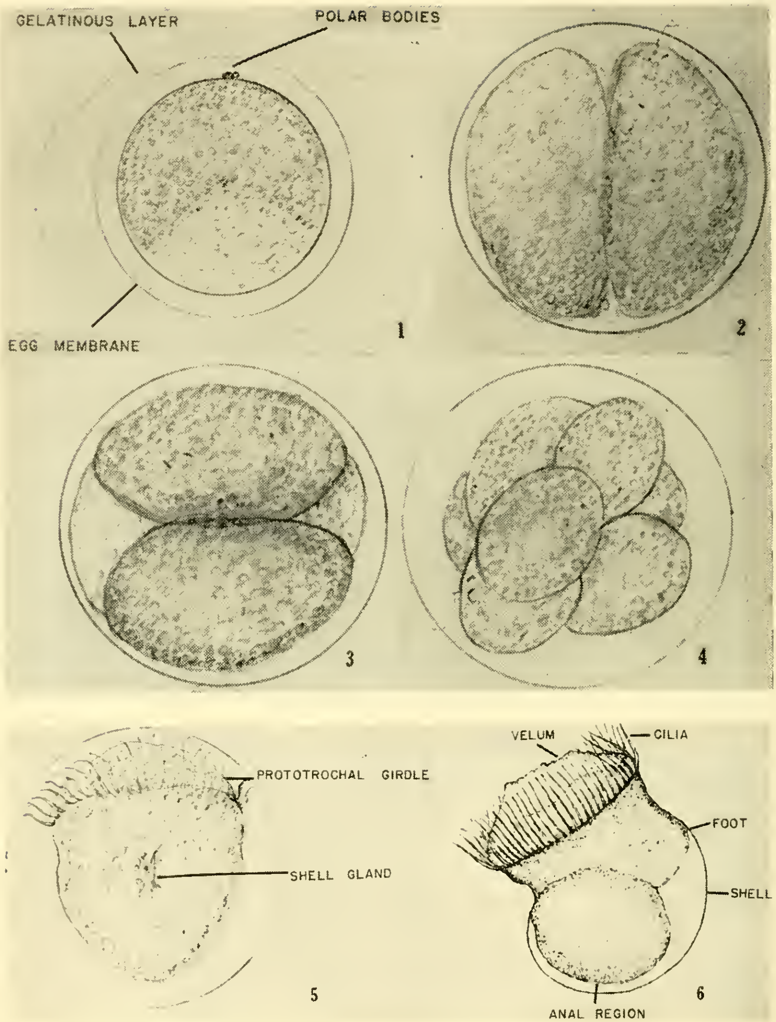
Historical account. The generic name *Haliotis,* meaning "sea-ear," was given by Linnaeus in 1758 in his "Systema naturae." Sea ears or abalones belong to the family Haliotidae, sub-class Streptoneura of the class Gastropoda, order Aspidobranchia, sub-order Rhipidoglossa. They have changed little since Oligocene times.

According to Crofts (1929, 1937, 1955) *Haliotis* shows many of the archaic features of the Aspidobranchia, retaining the original bilateral symmetry in the heart, excretory and respiratory systems. There is complete torsion of the mantle cavity and shell through 180 degrees.

Species of abalone are found along the west coast of North



1, 1a & 2: *Bursa finlayi* McGinty, paratype, apical whorls and type shell. 3 & 3a: *Bursa tenuisculpta* D. & F.: shell and operculum. 4 & 4a: *Colubraria monroei* McGinty, type shell. 5: *Rissoina sheaferi* McGinty, type shell. 6: *Fusilatirus ernesti* (Melville).



1, Fertilized ovum. 2, 2 cell stage, 2-¼ hours. 3, 4 cell stage, 5 hours. 4, 8 cell stage, 6 hours. 5, Trochophore, 16-18 hours. 6, Veliger, 28 hours.

America from Baja California in Mexico north into Alaska, at the Galapagos Islands, Japan, China, the Malay Archipelago, the Philippine Islands, Australia, New Zealand, South and West Africa, the Canary Islands, in the islands of the English Channel, the west coast of France and in the Mediterranean. They have also been found in small numbers on the tropical east coast of North America and off Brazil. There are about 90 living species. In most parts of the world except California, Japan and South Africa, abalones are too small to be of great value commercially. They are useful principally as curios and to shell collectors. In California, abalones are of giant size and constitute an important resource.

Early observations and experiments. In my experimental work at Hopkins Marine Station, I observed that it was easy to induce males in tide pools to give off sperm by disturbing them; it was impossible, however, to induce the females to give off eggs by the same technique. Early efforts to fertilize eggs by stimulating the females with naturally ejected sperm were successful, but the eggs failed to develop. However, on several occasions I could obtain two-cell stages. Several apparently ripe female abalones were injected with from 2 to 2.5 cc of KCl, isotonic with sea-water, in an attempt to induce spawning. All attempts, however, were unsuccessful.

Spawning technique. Ino induced Japanese species of *Haliotis* to spawn by increasing the temperature and pH of the water; Murayama (1935), also working with Japanese species, achieved success by adding sperm to water containing females.

A successful technique for inducing spawning in *Haliotis rufescens* was finally arrived at by the author in July, 1940 (Carlisle 1945). Successful spawning was accomplished during the months of July, August and September. Fifteen or 20 abalones per experiment were obtained by skin-diving in water from 4 to 18 feet deep. Since exposure to air was found to be necessary for successful spawning, these animals were brought to the laboratory dry, in large tubs. Desiccation for approximately one hour and 15 minutes was found to be the optimum.

Lunar periodicity and related tides could not be demonstrated as an influence on spawning. It appears unlikely that desiccation would act as a spawning stimulus because of a parallel

to conditions in nature. Only a comparatively small number of this species is found intertidally. In the central California area, although it is fairly common intertidally, it is found most abundantly in water 40 to 70 feet deep. In southern California, it is very rare in the intertidal zone, and occurs mainly in 20 to 100 feet of water.

During the period of desiccation, large quantities of sperm were given off by all males. This sperm was thoroughly washed over the entire body of each female; then all individuals of both sexes were placed in well-aerated salt-water tanks. These concrete tanks were out-of-doors and simulated quite well the abalone's natural environment. Brown kelp was provided as food.

Sperm continued to issue from the males until the water became cloudy and, in successful experiments, the females spawned within 6 to 8 hours after being placed in the tanks. This method, although not successful 100 percent of the time, was successful in over ⅔ of all experiments.

During spawning, large clouds of eggs were given off through all open respiratory apertures in the shell, either separately or in loosely-adhering masses. Eggs were transferred to the laboratory in finger bowls in which they had been allowed to settle during spawning. They were then transferred into beakers after several washings, to remove bacteria. Larvae in finger bowls died within 3 or 4 days but those kept in beakers in rotted sea water, (clean seawater kept in the dark for 6 months) and placed in a constant-temperature bath (temperature maintained between 17° and 19° C.) with continual, gentle, mechanical stirring, survived for 7 days and appeared close to metamorphosis, resting more and more on the bottom at this time. A shell develops during this period that can be seen on metamorphosed specimens, particularly small juveniles. It appears colorless and is distinct from the peristomal shell which develops later. The adult shell grows around the peristomal shell.

Development. Surface temperatures taken at Hopkins Marine Station (36° 37.2' N; 121° 54.2' W), in the area of greatest abundance of the species, ranged from a minimum of 10.5° C to a maximum of 18.3° C for the months of July, August and September during the period 1920 to 1955. The annual range for the same years was 8.3° C to 18.3° C.

Upon fertilization, an outer membrane is shed and the egg undergoes typical molluscan cleavage which continues until trochophore larvae develop in about 9 hours, each still enclosed in a thin membrane. Changes continue through the veliger stage, paralleling somewhat the development of *Patella* as described by Patten (1886), and quite close to that of Japanese species described by Ino and Murayama.

The trochophore breaks out of the membrane very slowly. Its cilia beat spasmodically and very rapidly, gradually distorting the membrane, and enlarging it at a weak point until it ruptures, liberating the free-swimming trochophore. At this stage it is very active, continually starting and stopping a fast ciliary beat, moving quite rapidly through the water. These larvae often rest with the prototroch up, then turn over and swim with the prototroch in front. They circle continually, clockwise as viewed from above.

When they stop, their cilia point downward; this is probably the beginning of the creeping stage. It seems to coincide with the onset of the veliger stage which occurs within 24 hours of fertilization. The shell also begins to appear at about this time.

Eggs and larvae contain much yolk and are opaque. Staining is therefore a problem. The most successful stain tried was acidulated borax-carmine, counterstained with induline and cleared in wintergreen.

Unfortunately, all preserved material was lost during my absence on military service during World War 2. Data on ova measurements were also lost. It is, however, deemed desirable at this time to present such material as is available.

As mentioned above, the eggs undergo typical molluscan cleavage (Pl. 4, figs. 1-4). The trochophore takes shape about 16 to 18 hours after fertilization (fig. 5). At this time, the prototrochal girdle is well-developed and the shell gland has become evident.

The larva is a well-developed veliger at about 28 hours, and the shell is evident. The foot and anal regions have become differentiated (fig. 6). Torsion has not yet begun.

An apical tuft reported by Ino (1952) for Japanese species was not seen on *Haliotis rufescens*.

Without preserved material, I do not feel justified in attempt-

ing description beyond this point and my notes and drawings cannot substantiate additional details.

Two major problems which were confronted during attempts to raise the larvae were sterility of equipment and feeding. Because of the delicacy of the eggs and larvae, complete sterility was a necessity and only new glassware was used. Filtered seawater proved unsatisfactory and only rotted seawater could be used. Bacteria and detritus were both lethal. Because of this, larvae were frequently transferred into clean rotted seawater. An eye-dropper proved better than a pipette for this purpose.

The feeding problem was not completely solved, but algal cultures of such species as *Spirillum* sp. and *Vibrio tyrosinatiens* appeared to be most suitable for the purpose.

Acknowledgments. During the course of this study many people assisted me. Some offered invaluable guidance and advice, especially Rolf L. Bolin; others who were particularly helpful in many ways were Albert E. Galigher, Harold Heath, Daniel Masters, Howard H. McCulley, Ragu Prasad, Tage Skogsberg, and James Willoughby. To these and all others who helped, I am sincerely grateful.

Literature cited

Carlisle, John G., Jr., 1945. Science *102* (2657) : 566-567.

Crofts, Doris R., 1929. Liverpool Marine Biol. Comm., Mem., *29:* 174 pp.

——1937. Roy. Soc. London, Philos. Trans., ser. B., Biol. Sci., *228* (552) : 219-268.

——1955. Proc. Zool. Soc. London, *125* (3, 4) ; 711-750.

Ino, Takashi, 1952. Biological studies on the propagation of Japanese abalone (genus *Haliotis*) Tokai Regional Fish. Res. Lab. Bull., no. 5, 102 p. (In Japanese with English summary).

Linnaeus, C. 1758. Systema naturae. Tom. 1 Regum animale. Editio decima, reformate. Holmiae, 824 p. (Facsimile reproduction, Brit. Mus. (Nat. Hist.) . 1939) .

Murayama, Saburo. 1935. Tokyo Imperial Univ., Coll. Agric., Jour. *13* (3) : 227-233.

Patten, W. 1886. Arb., Zool., Inst. Univ. Wien und Zool. Sta. Trieste *6* (Heft. 2) : 149-174.

U. S. Coast and Geodetic Survey. 1956. Surface water temperatures at tide stations, Pacific coast, North and South America and Pacific ocean islands. *Its* Spec. Pub. no. 280, 74 pp.

ON THE BIOLOGY OF SOME MOLLUSKS FROM A NOVA SCOTIAN DECIDUOUS WOOD

By E. J. DIMELOW, B.A., B.SC., PH.D.

In the border area between New Brunswick and Nova Scotia most of the land is low-lying and poorly drained. Climax deciduous forest is not very common and restricted mainly to hill slopes 600-1,200 ft. in height. A small area of such woodland is to be found, however, below the Fenwick picnic site along Route 2 between Amherst and Springhill at a height of 350 ft. on a gentle well-drained slope above St. George's Brook.

Land mollusks found in this wood in September and October, 1961, were as follows:

Slugs: *Philomycus carolinianus flexuolaris* (Rafinesque)
Pallifera dorsalis (Binney)
Arion circumscriptus (Johnston)
Deroceras reticulatum (Müller)
Arion subfuscus (Draparnand)

Snails: *Mesodon sayanus* (Pilsbry)
Oxychilus cellarius (Müller)
Zonitoides arboreus (Say)
Anguispira alternata (Say)
Discus cronkhitei cronkhitei (Newcomb)

The most common mollusk appeared to be *Pallifera dorsalis*, which was active in leaf litter about 2 feet thick. Three large specimens of *Philomycus* were found, all in fallen decaying tree trunks. While *D. reticulatum, A. subfuscus* and *A. circumscriptus* were common in the non-forested Limekiln Brook valley nearby, few were found in this wood. Only two empty shells each of *A. alternata* and *O. cellarius* were discovered but these appeared fresh. *Z. arboreus* and *D. cronkhitei* were present in several rotten logs.

Pilsbry (1948) described *Philomycus* as occuring in Maine and Oughton (1948) listed it for south Ontario. It has not been located before in the Maritime Provinces of Canada. *Pallifera dorsalis* has not been noted since 1906 when Campbell found it near Pictou, N. S. Ord and Watts (1949) obtained only *Deroceras laevae* from Oxford in this area, though they found *D. reticulatum, A. circumscriptus* and *A. subfuscus* commonly in eastern Nova Scotia. *Mesodon sayanus* was recorded for western New Brunswick by Bailey (1903). It was not listed for Nova Scotia

or Cape Breton by Jones (1877) or Macmillan (1954).

The specimens of *P. dorsalis* had an interrupted black line running down the back and 7 teeth (the typical number) on the jaw. The shell of the *Mesodon* was slightly angulate.

The red-backed salamander (*Plethodon cinerarius*) which may prey on some of the mollusks, occurs in almost all decaying logs in the wood. The worms *Allolobophora caliginosa, Lumbricus castaneus,* the wood-lice *Porcellio rathkei* and *Cylisticus convexus* also occur in the stumps along with larvae of Coleoptera and Diptera. These could form alternative prey for the salamanders.

American beech, sugar and red maple, striped maple, mountain maple (*Acer spicatum*), white ash (*Fraxinus americana*), yellow birch and a little red spruce (*Picea rubens*), all grow in this wood. Basswood (to which the *Philomycus* is supposed to be partial) is not present. Low growing honeysuckle, moosewood (*Viburnum alnifolium*) and yew (*Taxus canadensis*) two feet high or less, form the underbrush along with taller elder (*Sambucus canadensis*). Clubmosses (*Lycopodium obscurum* and *L. lucidulum*) rise from the leaf litter along with flowering plants such as *Fragaria vesca, Streptopus roseus, Maianthemum canadense, Trillium undulatum* and *T. cernuum, Clintonia borealis, Medeola virginiana, Cornus canadensis, Actaea alba, Linnaea borealis, Oxalis montana, Trientalis borealis, Viola incognita* and *Mitchella repens.*

All the flowering plants listed above were offered to a specimen of *Philomycus* as food under laboratory conditions during the autumn and late spring but none were accepted. It was very difficult to see whether the *Philomycus* and the *Mesodon* fed on rotten wood, but they were observed to crop the lichens, *Lobaria pulmonaria* (L.) Hoffm. and *Lobaria quericizans* Michx. present on bark taken from the decaying trunks in which they were originally found. The food of *Pallifera* seemed to consist of damp detritus and decaying leaves.

Toadstools (including the morel) found on the Mount Allison University Campus were eaten more rapidly by the *Philomycus* than lichens. One lichen, *Parmelia sulcata Tayl.,* present on campus trees was, however, taken readily. This lichen was parasitized by a discomycete fungus bearing brown cushion-like fruiting bodies. Non-parasitized *Parmelia* was eaten more slowly.

Rush (1920) noted that *Philomycus* fed through the winter on fungus. This may be its main natural food, assisted by lichens.

Specimens of *Philomycus* and *Pallifera* remained active while kept in captivity at a temperature of 20°C. throughout the winter of 1961-62. Both took to feeding mainly on carrot slices during this time. Microscopic examination of the faeces of the *Philomycus* revealed the presence of liberated chromoplasts containing carotenoid pigment and of empty carrot cells with collapsed walls. This faecal matter was sometimes reingested and subjected to further digestion. *Philomycus* may possess digestive enzymes similar to those of other slugs and may not be limited to a diet of fungus and lichens on account of specialisation in this respect.

I am indebted to Dr. Roland Beschel for identifying the lichens and to Allen Rebuck for checking the identifications of some of the plants from Fenwick.

References

Bailey, G. W. 1903. Bull. Nat. Hist. Soc. N. B., *21*.
Bett, J. A. 1960. Proc. Zool. Soc. Lond. 135.
Campbell, A. R. 1906. The Mollusks of Pictou County. *Bull. Pictou Acad. Sci.*, 1.
Cunningham, G. C. 1956. Native trees of Canada. Dept. of Northern Affairs and National Resources Canada.
Gleason, H. A. 1952. The new Britton and Brown illustrated flora, Vols. 1-3. The New York Botanical Garden, N. Y.
Jones, J. M. 1877. Mollusca of N.S. Proc. N.S. Inst. Sci., *4*.
La Rocque, A. 1953. Nat. Mus. Canada Bull. 129.
Macmillan, G. K. 1954. Proc. N.S. Inst. Sci., *23*.
Mellanby, K. 1961. Nature Lond. *189*.
Oughton, M. J. 1948. Land snails of Ontario. University of Toronto biological Series, *57*.
Ord, J. J., and Watts, A. H. G. 1949. Proc. N. S. Inst. Sci., *23*.
Pilsbry, H. A. 1939-1948. Land Mollusca of North America, Vols. 1 and 2. Acad. Nat. Sci. Phila., monograph 3.
Quick, H. E. 1949. Slugs. Linn. Soc. Lond., synopsis 8.
Rush, C. R. 1920. Nautilus *33*.

LAND MOLLUSKS OF SACKVILLE NEW BRUNSWICK, CANADA

By E. J. DIMELOW, B.A., B.SC., PH.D.

Based on collections made in the St. John area and western part of the province adjacent to Maine, Bailey (1903) wrote an account of the land snails of New Brunswick but the slugs of

the province and the land snails of the eastern part have never been described.

The following land mollusks are found on the Mount Allison University Campus, in Sackville, in the east of New Brunswick, near the Nova Scotia border:

Snails: *Hygromia hispida* (L)
Oxychilus cellarius (Mueller)
Zonitoides arboreus (Say)
Zonitoides nitidus (Mueller)
Discus cronkhitei cronkhitei (Newcomb)
Cionella lubrica (Mueller)

Slugs: *Deroceras laeve* (Mueller)
Deroceras reticulatum (Mueller)
Arion circumscriptus (Johnston)
Arion subfuscus (Draparnand)

Z. nitidus is very common under fallen logs surrounded by marsh vegetation in a water meadow periodically flooded. *Hygromia hispida* (possibly introduced since 1903), *C. lubrica* and the slugs listed above, occur in this situation but also elsewhere. *Zonitoides arboreus* and *D. cronkhitei* are found in rotten logs in a small scrubby deciduous wood. As well as occurring in this wood, *D. reticulatum, A. circumscriptus, O. cellarius, H. hispida,* all European introduced species, are the only mollusks to be found under logs, stones, and leaf litter in a large hollyhock bed or in patches of European ground ivy (*Glecoma hederacea* L.). Unlike other slugs *Arion subfuscus* is not common in the situations listed above but is a little more plentiful in a disused sandstone quarry containing a lake, trees and non-cultivated plants.

Similar disused sandstone quarries occur above the Bay of Fundy shoreline beyond Westcock Marsh about four miles from Sackville. Here *D. reticulatum, A. circumscriptus* and *O. cellarius* are to be found about half a mile from the nearest habitation and appear able to withstand severe winters. They survived under snow 2-3 feet thick which lay on the ground continuously in the winter of 1960-61 from Dec. 25th until April 30th and were to be found under pieces of wood and stones as the snow was melting on May 1st and 2nd. When brought into the laboratory, they were immediately active at a temperature of 20°C. Usually snow lies on the ground discontinuously here from early January till mid April. Mellanby (1961) found that in the laboratory *D.*

reticulatum moves and feeds at 0.8°C. without any need for temperature acclimatisation. Possibly *A. circumscriptus* may share this ability to maintain activity at low temperatures.

If brought indoors in autumn all the snails, *D. reticulatum* and *A. circumscriptus* feed and survive through the winter at a temperature of 20°C. *Deroceras reticulatum* lays eggs frequently during this time, whereas *A. circumscriptus,* though adult, lays few. *Arion subfuscus* adults, under such conditions, lay clusters of large eggs, then die by November, while their young hatch and grow during the winter. As the autumn here is normally mild and prolonged, possibly the eggs might hatch out of doors. The breeding seasons of these slugs seem to be similar in New Brunswick to those recorded for England (Quick, 1949; Bett, 1961) and for Nova Scotia (Ord and Watts, 1949).

ZINC EFFECTS ON FRESH-WATER MOLLUSKS

By CHARLES B. WURTZ
Consulting Biologists, Inc., Spring House, Pa.

The increasing emphasis upon pollution control during the past two decades has generated a great many specific studies on potential pollutants. Among these is zinc, and several studies have been made upon this metal in surface waters. This paper presents the result of studies on zinc in the field and laboratory during the past 4 years.

The field studies were done in conjunction with a comprehensive biological survey of the Northwest Miramichi River, New Brunswick, Canada. The laboratory studies undertaken were part of a series done under the terms of a Public Health Service Grant (RG-6871).

To study the biological effects of heavy metals in streams it is necessary to recognize, first, that natural concentrations of these metals occur in unpolluted streams, and, second, that some degree of tolerance to metals is inherent in aquatic organisms.

In mining exploration, ore bodies are commonly located by surface outcroppings. Such surface exposures are the product of erosion, and the weathering of these exposures is the source of natural stream loads of metals. Where mining is undertaken, additional amounts of ore are exposed to the action of weathering, and the amount of metal in streams draining the area is increased.

To the extent that studies have been made, it would appear that streams draining zinc-mining districts show an average of 0.53 parts per million (ppm) of zinc. In natural waters not subject to mine drainage or industrial wastes zinc concentrations may range to 0.200 ppm. (Renn, et al, 1962)

Zinc is not highly toxic to humans. Data on drinking waters compiled from 37 locations in the United States showed a mean value of 0.136 ppm of zinc. The United States Public Health Service recommends a maximum of 15 ppm of zinc for drinking water standards.

Living organisms all require certain minimal amounts of metals. Zinc and copper, for example, are necessary for the formation of certain enzymes. These constitute two of the vitally necessary trace elements. Different groups of animals vary in their resistance to metals when these are present in amounts above the required physiological minimum. The mollusks, in general, are the least resistant to overloads of heavy metals in streams. (This is shared by the malacostracan crustaceans; the oligochaete worms are the next least tolerant group.) The mollusks would be the first animals eradicated when a stream became overloaded with metals. For this reason, these animals are of particular importance when making field observations on streams where metal overloading may occur.

Once the mollusks are eliminated from an extensive stream stretch they are slow to re-invade the area, and usually become re-established only through downstream transport from an upstream area. Such transport, being adventitious, is fortuitous. Considerable time may elapse before the mollusk population is again established. In the Ystwyth River in Wales, Jones (1958) reported that 35 years after the closing of a lead mine the stream was carrying 0.2 to 0.7 ppm of zinc. Although brown trout were present the bottom organisms were almost entirely lithophilous insects.

On June 15, 1960, dewatering of a base-metal (Zn, Pb, Cu) mine that had been closed was begun preparatory to renewing mining operations. This mine is in the drainage basin of the Tomogonops River, a tributary of the Northwest Miramichi River, New Brunswick, Canada. The water pumped from the mine flowed about 6 miles before entering the Northwest Mira-

michi River. The discharge water apparently eliminated the mollusk population in the Northwest Miramichi below the mouth of the Tomogonops River for a distance of at least 12 miles (but not for as much as 17 miles). In July, 1961, mollusks were still missing from this stream stretch, although 77 species of other macro-invertebrate animals were found. At the same time, in the stream above the mouth of the Tomogonops River 87 species of macro-invertebrate animals were found including 5 species of mollusks. Apparently within one year of the mine dewatering incident, the stream had a normal population except for the mollusks.

In 1961 the Salmon Investigation Group (Department of Fisheries of Canada) had placed a cage of young salmon (parr) in the Northwest Miramichi River where the fish were almost continuously in the flow of water from the Tomogonops River. Twice within a period of 3 days in July, 1961, a specimen of *Helisoma anceps* was taken from the leading face of this cage. These snails had apparently been flushed downstream from a population established in a quiescent stretch of the Northwest Miramichi about one-half mile above the mouth of the Tomogonops. These two occurrences are characteristic of the adventitious distribution of aquatic snails. This species is not adapted for survival in rapidly flowing streams and would not be expected to occur in the areas of the river critically examined during the survey. The average velocity at the stations studied on the Northwest Miramichi was 1.35 feet per second during the time of the survey (which was conducted during a low-water period). At this velocity the stream was flowing one mile in 65 minutes, which is about double the velocity of the lowland stretches of our major east coast rivers where *Helisoma anceps* is of common occurrence. *H. anceps,* and its eggs, occurred in quiescent water 9 miles below the mouth of the Tomogonops in July, 1962.

The mollusks found in the Northwest Miramichi River in 1961 above the mouth of the Tomogonops included: *Margaritana margaritifera, Pisidium casertanum, Ferrissia tarda, Physa gyrina* and *Helisoma anceps.* In the Portage River, a slow-flowing tributary of the Northwest Miramichi, which enters the main river about two miles below the Tomogonops River, 5 mollusks also occurred. These were: *M. margaritifera, Lampsilis radiata, Amni-*

cola limosa, P. gyrina and Gyraulus arcticus. Of the 5 species found in this small tributary only two were shared with the Northwest Miramichi. The Portage River is highly eutrophic and had an average velocity of 0.85 feet per second. Within the confines of one station (a 100-foot stretch) 92 species of macro-invertebrates were found. This is an uncommonly high species diversity in a small stream (width 36 feet with a low-water discharge of 3,000 gallons per minute).

The Northwest Miramichi, with its complex of tributaries, drains an area characterized by the sporadic occurrence of complex ores. Zinc, lead and copper are found throughout the region, and these minerals must have been leaching downstream over many millennia. A geochemical survey was conducted in this region a few years ago while searching for ore bodies. In the stream sediments of the headwaters of the Tomogonops River and its branches, values found for zinc ranged from 50 to 300 ppm; for lead from 0 to 400 ppm; for copper from 25 to 75 ppm. This, of course, represents the natural occurrence of these metals in the stream sediments. The waters of this stream system must have been carrying a heavy metals load throughout geological time. Other tributary complexes of the Northwest Miramichi must also have metals in the stream sediments. The Portage River, for example, has a recorded value of 0.005 ppm of zinc for the stream water in that area where 92 different species of bottom organisms were found. The Little River, a tributary of the Northwest Miramichi entering above the mouth of the Tomogonops, has a recorded value of 0.007 ppm of zinc for the stream water. Water of the Sevogle River, a major tributary of the Northwest Miramichi entering the main river about 15.5 miles below the Tomogonops River, has a recorded value of 0.003 ppm of zinc.

Mullican, et al, (1960) found that an industrial waste carrying 65 ppm of zinc acted as a biological depressant. They reported that in the Nolichucky River (Tennessee) zinc at this concentration reduced the resident population from 2,934 individuals in 30 genera per square foot to 46 individuals in 22 genera per square foot.

Some time after the dewatering of the mine into a branch of the Tomogonops River analyses* were begun and regularly

* Colorimetric determination by dithizone extraction.

made on the amount of total heavy metals (THM-zinc, lead, copper) in the water at the mouth of the Tomogonops where it joins the Northwest Miramichi. The highest values recorded up to July 5, 1961, when the comprehensive biological survey was begun, were 8.90 and 10.0 ppm THM on October 25, 1960. Twenty-four hours later 2.80 and 2.21 ppm THM were recorded here. At Wayerton, about nine miles below the mouth of the Tomogonops, values of 0.52 and 0.57 ppm of total heavy metals were recorded on October 26th. By November 12, 1960, the total heavy metals content at the mouth of the Tomogonops had fallen below 1.0 ppm, and this was not exceeded subsequently. During the same period THM values at Wayerton did not exceed 0.2 ppm. Because the mouth of the Tomogonops is inaccessible throughout the winter and into late spring the measurements at Wayerton are important. From November 12, 1960, through July 4, 1961, the record THM values at this location fell between 0 and 0.049 ppm on 116 days, between 0.050 and 0.099 on 62 days, and between 0.10 and 0.19 on 22 days. At these concentrations over an 8-month period the river below the mouth of the Tomogonops supported (or developed) a complete and diverse population of macro-invertebrate animals except for the mollusks. During the course of the comprehensive biological survey begun on July 5, 1961, a total of 132 macro-invertebrate species was taken from the Northwest Miramichi River. An additional 25 species were found in the Portage River.

The toxicity of heavy metals in surface waters is affected by several factors. Chief among these would be the hardness of the water and its hydrogen-ion concentration (pH). Calcium is antagonistic to the metals. Alkaline water precipitate the metals in the form of insoluble, and harmless hydrates. Acid waters dissolve hydrates and bring the metals into solution.

The Northwest Miramichi is a soft-water stream with a total hardness (as $CaCO_3$) ranging from 17.5 to 24.8 ppm. During the survey the pH range was 7.3 to 7.6. The Portage River had a hardness of 15.5 ppm with pH 7.1, and the Tomogonops River had a hardness of 49.2 ppm and a pH of 7.4 to 7.7. The hardness of the Tomogonops River stemmed from the liming technique practiced by the mine to prevent stream pollution. This practice also increased the hardness of the Northwest Miramichi itself

Table 1

TLm in ppm of Zinc Sulfate for Physa heterostropha

Time	Hard Water	Soft Water
24 hours	18 (4.07 ppm Zn);	12.0 (2.71 ppm Zn)
48 hours	16 (3.62 ppm Zn)	6.1 (1.48 ppm Zn)
72 hours	14 (3.16 ppm Zn)	4.9 (1.11 ppm Zn)
96 hours	14 (3.16 ppm Zn)	4.9 (1.11 ppm Zn)
120 hours	--	4.9 (1.11 ppm Zn)

Table 2

TLm in ppm of Zinc Sulfate for young Physa heterostropha

Time	Hard Water Series	Soft Water Series
	51°F	51°F
24 hours	4.20 (0.949 ppm Zn)	1.92 (0.434 ppm Zn)
48 hours	1.92 (0.434 ppm Zn)	1.92 (0.434 ppm Zn)
72 hours	1.92 (0.434 ppm Zn)	1.34 (0.303 ppm Zn)
96 hours	1.92 (0.434 ppm Zn)	1.34 (0.303 ppm Zn)
	55°F	55°F
24 hours	6.95 (1.57 ppm Zn)	2.37 (0.536 ppm Zn)
48 hours	6.17 (1.39 ppm Zn)	2.37 (0.536 ppm Zn)
72 hours	6.17 (1.39 ppm Zn)	2.37 (0.536 ppm Zn)
96 hours	6.17 (1.39 ppm Zn)	1.92 (0.434 ppm Zn)
	68°F*	68°F*
24 hours	15.5 (3.50 ppm Zn)	2.95 (0.667 ppm Zn)
48 hours	12.2 (2.76 ppm Zn)	2.37 (0.536 ppm Zn)
72 hours	8.66 (1.96 ppm Zn)	1.92 (0.434 ppm Zn)
96 hours	7.50 (1.70 ppm Zn)	1.92 (0.434 ppm Zn)
	90°F	90°F
24 hours	5.66 (1.28 ppm Zn)	2.65 (0.598 ppm Zn)
48 hours	4.90 (1.11 ppm Zn)	2.65 (0.598 ppm Zn)
72 hours	4.90 (1.11 ppm Zn)	1.55 (0.350 ppm Zn)
96 hours	4.90 (1.11 ppm Zn)	1.55 (0.350 ppm Zn)

*These bioassays were done with an organic substrate in the dilution water. The substrate material=0.1 gm uncooked Wheatena in the 188 ml of material in the experimental jars

below the mouth of the Tomogonops River.

In the laboratory, bioassays were done using zinc sulfate, $ZnSO_4 \cdot 7H_2O$ (22.6% Zn), in both soft (20 ppm total hardness) and hard (100 ppm total hardness) waters. The pH of these two waters was 7.3 and 7.8 respectively. The mollusk used as an experimental animal was the pond snail, *Physa heterostropha.* The bioassay is designed to establish the median tolerance limit (TLm), which is that concentration of tested material that results in 50% kill and 50% survival of the test animals. Table 1 presents the bioassay results for tests done at 70±2°F using adult snails of 12 to 15 mm. total shell length.

Since young animals are more susceptible to adverse influences additional bioassays were done on snails of 3 to 6 mm. total shell length. The effects of temperature was also measured in this series of tests. Table 2 summarizes these data.

In addition to *Physa heterostropha,* adult ramshorn snails, *Helisoma campanulatum,* were subjected to bioassays with zinc sulfate. These snails are characterized by the presence of haemoglobin in the circulatory system rather than haemocyanin as is the case in *Physa.* Table 3 presents the results of these bioassays.

Table 3

TLm in ppm of Zinc Sulfate for Helisoma companulata

Time	Hard Water Series	Soft Water Series
	55°F	55°F
24 hours	49.0 (11.07 ppm Zn)	49.0 (11.07 ppm Zn)
48 hours	49.0 (11.07 ppm Zn)	38.5 (8.70 ppm Zn)
72 hours	13.4 (3.03 ppm Zn)	4.25 (0.96 ppm Zn)
96 hours	13.4 (3.03 ppm Zn)	3.85 (0.87 ppm Zn)
	73°F	73°F
24 hours	23.4 (5.29 ppm Zn)	56.0 (12.66 ppm Zn)
48 hours	23.4 (5.29 ppm Zn)	8.30 (1.88 ppm Zn)
72 hours	5.60 (1.27 ppm Zn)	6.53 (1.48 ppm Zn)
96 hours	5.60 (1.27 ppm Zn)	5.60 (1.27 ppm Zn)

In spite of the anomaly of a TLm of 56 ppm of zinc sulfate in 24 hours at 73°F, snails containing haemoglobin evidently are more tolerant of zinc than those containing haemocyanin. These snails apparently will withstand 48-hour surges of wastes bearing high concentrations of zinc.

Copper is more toxic than zinc, apparently being exceeded in its toxicity only by mercury and silver among the metals. Bioassays of copper sulfate, $CuSO_4 \cdot 5H_2O$ (25.5% Cu), were done using *Physa heterostropha* as the test animal. The results of these tests, all done at 70±2°F, are presented in Table 4.

Table 4

TLm in ppm of Copper Sulfate for Physa heterostropha

Time	Hard Water	Soft Water
	Adults	
24 hours	0.56 (0.143 ppm Cu)	-
48 hours	0.27 (0.069 ppm Cu)	-
72 hours	0.27 (0.069 ppm Cu)	-
96 hours	0.27 (0.069 ppm Cu)	-
	Young	Young
24 hours	0.135 (0.034 ppm Cu)	0.18 (0.046 ppm Cu)
48 hours	0.050 (0.013 ppm Cu)	0.075 (0.019 ppm Cu)
72 hours	0.050 (0.013 ppm Cu)	0.070 (0.018 ppm Cu)
96 hours	0.050 (0.013 ppm Cu)	0.062 (0.016 ppm Cu)
	Young*	Young*
24 hours	0.56 (0.143 ppm Cu)	0.56 (0.143 ppm Cu)
48 hours	0.207 (0.053 ppm Cu)	0.134 (0.034 ppm Cu)
72 hours	0.207 (0.053 ppm Cu)	0.134 (0.034 ppm Cu)
96 hours	0.207 (0.053 ppm Cu)	0.134 (0.034 ppm Cu)

*Cf. footnote of Table 2

The greater resistance of young snails to copper sulfate in soft water as compared to those in hard water, in the test lacking an organic substrate, is a surprise. The opposite condition would be expected. Repetitive testing has not been undertaken to date.

The median tolerance limit value is used to derive a biologically safe disposal rate for toxicants being introduced into a receiving stream. The disposal rate is based upon several variables including the sensitivity of the experimental animal, the maximum potential discharge load, the rate of loss of the toxic effect, the potential minimum flow of the receiving stream, and others. Safe disposal rates must be determined for each specific dis-

charge. No empirical factor can be properly applied to the preceding TLm values to derive a general "rule" for the safe disposal of metals.

Bibliography

Consulting Biologists, Inc., 1961, A Biological Survey of the Northwest Miramichi River, Spring House, Pa.

Jones, J. R. E., 1958, Journ. Animal Ecol., 27 (1) :1-14.

Mullican, H. N., R. M. Sinclair and B. G. Isom, 1960, Aquatic Biota of the Nolichucky River, Tenn. Stream Pollution Control Board, Nashville.

Renn, C. E., J. T. O'Connor and B. Wintner, 1962, Interim Report A.E.C. Contract AT (30-1) 2536, Johns Hopkins Univ., Baltimore.

Wurtz, C. B., 1961, Proc. Pa. Acad. Sci., 35:51-56.

PELECYPODS FROM BARRA DE NAVIDAD, MEXICO

By HAROLD E. and EMILY H. VOKES

Early in December, 1961, we had the opportunity of collecting for an hour or two on the beach at Barra de Navidad, Jalisco, a village on the southwest coast of Mexico approximately 30 miles northwest of Manzanillo, Colima. As the name indicates, Barra de Navidad is located on a sand bar, or spit, that extends from the main shore southward towards Punta Hermosa, a large and rugged headland formed of metamorphic rocks of Paleozoic (?) age. Separating the headland from the terminus of the spit is a narrow inlet that leads to a broad, mangrove-bordered lagoon on the east side of the bar. To the west is an open bay connecting with the Pacific Ocean between several small rocky islets. The combination of these geographic features affords widely diverse ecologic situations that result in an unusually rich molluscan fauna. The recent completion of a paved highway connecting with Manzanillo and thence to Guadalajara, and the completion, in December, 1960, of a first-class hotel near the village makes the area one of unusual attraction for the collector.

Our collections, made only on the beach and within a very short time on an advancing tide, include 87 different molluscan species, plus coral fragments. The majority of the Mollusca are forms normal to the fauna of the region as it is presently known. There are, however, a few species among the pelecypoda that are worth special attention at this time.

Perhaps the most abundant shell on the western side of the

bar, represented in our collection by more than 60 specimens, is *Semele lenticulare* (Sowerby), a species reported by Olsson (1961, p. 363) as ranging from Panama southward to Peru. It is not included by Keen in her "Sea Shells of Tropical West America" apparently being considered as beyond the geographic limits of that work. In view of the great extension of range indicated (about 2,000 miles), specimens were sent to Dr. Olsson who kindly confirmed the identification, writing: "The *Semele* I would identify as *S. lenticulare*. Your specimens agree exactly with shells I have from Ecuador and Panama. It is a common shell everywhere and its extension north is no surprise to me."

Also in the collection is a single right valve of *Semele sparsilineata* Dall, a species reported as ranging from Nicaragua to Panama (Olsson, 1961, p. 363; Keen, 1958, p. 200). This specimen is probably somewhat immature, being 20 mm. in length, but agrees with *sparsilineata* in shape, ornamentation, and color pattern including the brownish-purple zigzag markings.

A species of *Neocyrena* that is very closely related to *N. radiata* (Hanley) is represented by 4 specimens, only one of which is fully adult. This specimen agrees in shape with *radiata* but is bleached and the color pattern is not clear. The 3 more immature specimens show radiating purplish rays toward the external ventral margin and have an interior that is violent in color with the area outside of the pallial line of a distinctly darker shade. These specimens are, however, a little less inflated, proportionately, than is the adult specimen and the umbo is as a result slightly less prominent than it is in the illustrated specimens of *radiata* (Olsson, 1961, pl. 28, figs. 5-5c; Keen, 1958, fig. 177, p. 91). If these specimens are correctly identified as *radiata,* they also represent an extension northward for the previously reported range of Nicaragua to Ecuador.

Finally, opportunity is here taken to disagree with Olsson's conclusions (1961, p. 346) in regarding *Amphichaena kindermanni* Philippi as synonymous with *Donax culter* Hanley. The collections from Barra de Navidad contain three specimens of *Amphichaena,* one of which is 41 mm. in length, almost one-fourth longer than the largest adult of *D. culter.* The umbos are slightly in advance of the midline (see Keen, 1958, fig. 463, p. 189), rather than posterior to it, as in *culter,* and are lower and

much less inflated. Well-preserved specimens lack minute denticulations or punctations in the finely grooved interspaces between the surface ribs. Internally, there are strong marginal crenulations anterior to the midline, but these are absent posteriorly, except on a few specimens that reveal microscopic crenulations at the extreme posterior terminus of the valve; specimens of *Donax culter,* collected near Manzanillo have the margins crenulate throughout, although the strongest crenulations tend to be near the anterior end. *D. culter* was not found at Barra de Navidad, where our collections include *D. gracilis* Hanley (abundant) and *D. punctostriatus* Hanley (common).

We are inclined to agree with Olsson however, in the belief that the sum total of the characteristics of *Amphichaena* suggest its relationship with the Donacidae rather than the Psammobiidae, where it was placed by Thiele (1935, p. 910), or the Sanguinolariidae to which it was referred by Keen (1958, p. 188).

References

Keen, A. Myra, 1958, Sea shells of tropical west America; xii, + 624 pp., illus., Stanford Univ. Press.

Olsson, Axel A., 1961, Mollusks of the tropical eastern Pacific: Panamic-Pacific Pelecypoda, 574 pp., 86 pls., Paleont. Research Inst., Ithaca, N. Y.

Thiele, Johannes, 1935, Handbuch der systematischen Weichtierkunde, Bd. 2, T. 3, pp. 779-1022, illus., Jena.

FURTHER STUDIES ON THE MARINE MOLLUSKS OF CAPE ANN, MASSACHUSETTS

By RALPH W. DEXTER, Department of Biological Sciences, Kent State University, Kent, Ohio

The marine mollusks at Cape Ann, Massachusetts, have been studied intensely in recent years by the writer (1942, 1944, 1945a, 1945b, 1947, 1956, 1961) and by Clarke (1954). A survey of the marine life at Cape Ann made by the writer in the summers of 1933-1937 was repeated in the summers of 1956-1961.[1]

The writer has periodically taken intertidal quadrat samples at 15 stations along the Annisquam River (tidal inlet) and on

[1] Acknowledgement is made to the U. S. Atomic Energy Commission, Contract AT(11-1)-411, for financial support given to this project. Also, to John Auditore for field assistance, and to Dr. William J. Clench, Dr. Ruth D. Turner, Dr. Ernest Marcus, and Dr. George M. Moore for making certain determinations.

adjacent shores of Gloucester Harbor and Ipswich Bay, in addition to general collecting in the area. Bottom dredging has been conducted along the entire bottom of the Annisquam River and in the shallow margins of Gloucester Harbor and Ipswich Bay. Altogether, 53 species of mollusks have been collected along with other marine animals. Clarke (ibid.) based his study on beach shells from Wingaersheek Beach, collected especially after storms, specimens brought in on the gill nets of fishermen, and shells from the stomachs of bottom-feeding fishes captured in the Cape Ann region. Altogether he reported 97 species. The published studies of Clarke and myself complement each other since the methods of collecting and the areas examined were different. Together they give a fairly complete picture of molluscan life in this area. In the summers of 1956-1961 the writer continued studies on marine life in this area. New and additional information on mollusks are recorded here. For the most part, names follow usage as given in Abbot (1954).

I. New Records for Cape Ann.

Symmetrogephyrus vestitus (Broderip and Sowerby). This species, known as the Concealed Arctic Chiton, was dredged from Ipswich Bay 20 July 1956.

Clione limacina (Phipps). This pteropod, known as the sea butterfly, was collected in Gloucester Harbor by John Auditore in May, 1961.

Acanthodoris pilosa (O. F. Müller) has been collected along spring low water line of the Annisquam River in recent years.

Facelina bostoniensis (Couthouy) has been dredged from the River and Ipswich Bay in recent years.

Polinices duplicatus (Say). Clarke (1954) concluded that Dane State Beach in Beverly "seems to be the northern limit." However, this species was collected in the Annisquam River 21 July 1960. It was dredged from the middle of this tidal inlet at the junction of Little River. Its presence has been suspected when shells were collected in the summer of 1959 from this same area. This species was listed for Cape Ann by Townsend (1905, p. 19), but the specimen dredged in 1960 was the first live specimen collected here in recent years. Presumably this now becomes the northern limit.

Urosalpinx cinerea (Say). This species, rare and local in its

occurrence north of Cape Cod, was collected in the Little River branch of the Annisquam River 21 August 1957, 3 September 1957, and 31 July 1958. It was also dredged from Ipswich Bay 2 September 1957.

Mitrella lunata (Say) was collected from colonies of hydroids in the Annisquam River 21 July 1956, from Little River 31 July 1958, and from Ipswich Bay in 1958.

Ovatella myosotis (Draparnaud) was found in the crevice of a stone wharf at the upper end of Lobster Cove near mean high water line 30 July 1958, and again on a high marsh of fox grass on the Annisquam River 9 August 1958.

Haminoea solitaria (Say). A shell of this species was collected on a rocky shore of Gloucester Harbor 9 September 1960. It has not yet been found living in the area.

Littorina saxatilis groenlandica. According to Bequaert (1943) "there appear to be no true geographical races or subspecies" of *L. saxatilis.* However, the colony of this species at Bass Rocks is uniformly of a greenish-white color, and this coloration has not been found in other specimens on Cape Ann. While the trinominal may not be valid, the colony is certainly distinct. This was first discovered by Mrs. Otis Dana in 1950, and specimens have been collected by both of us in recent years.

Yoldia limatula (Say). This species has been dredged in Gloucester Harbor during the summers of 1958-1961.

Musculus discors (Linn). This species was taken by a fishing dragger off Cape Ann in November, 1961. Specimens were sent to the writer by John Auditore.

II. Confirmed Records Based on Living Specimens.

The following species, which have been reported in recent years on the basis of dead shells collected, have now been collected alive on Cape Ann.

Periploma leanum (Conrad) was collected alive at Wingaersheek Beach 9 July 1956.

Cyrtodaria siliqua (Spengler) was dredged alive from Ipswich Bay in the summer of 1957.

Thracia conradi Couthouy was dredged alive in Ipswich Bay in October, 1957.

Lunatia triseriata (Say) was dredged from Ipswich Bay in the summer of 1958.

Colus pygmaeus (Gould) was collected alive from Ipswich Bay 22 August 1959. Two specimens were collected.

III. Changes in Local Distribution.

Brachidontes demissus (Dillwyn) was more widely spread in the marshes of the Annisquam Inlet during the 1956-1961 period. It has been found in all of the marshes of this region which have been examined.

Spisula solidissima (Dillwyn) has been taken in recent years in the Annisquam River as well as at Wingaersheek Beach where it has been the dominant bivalve for many years. Large specimens were taken by the Perrini dredge in 1957 when the channel of the Annisquam River was deepened and widened at certain points. Also, immature specimens were dredged by the writer each summer in recent years.

Placopecten magellanicus (Gmelin) was collected from Gloucester Harbor for the first time in 1960. Fishing draggers frequently pick up this species from Ipswich Bay.

Cerastoderma pinnulatum (Conrad), formerly reported by the writer from the Annisquam River and by Clarke from fish stomachs, was dredged from Ipswich Bay on 20 July 1956.

Nassarius obsoletus (Say) was more widely spread in the Annisquam Inlet in the 1956-1961 period than during the 1933-1937 period. It has become a common species on many of the mud flats and in the marsh creeks throughout the area. It is far more abundant than indicated by Clarke (1954). A dense population of this species found for many years at Station J very suddenly and completely abandoned its former site in 1960 as reported earlier (Dexter, 1961). In the summer of 1961 this species remained off the sampling station, which then became rather heavily coated with a green alga, *Enteromorpha intestinalis.* The snails continued in their usual abundance, however, at a nearby location.

Lacuna vincta (Turton) has in recent years been returning to the eel grass (*Zostera maritima*) as this has spread and increased gradually in the Cape Ann area. This snail is returning to its former habitat from the brown algae on which it took refuge after the disappearance of eel grass in 1932.

IV. Notable Changes in Abundance.

Littorina saxatilis (Olivi) was observed to undergo a most

remarkable increase in abundance between 1933-1937 (Dexter, 1944). In 1956 this species was much less numerous than in 1936 when it was at the peak of its abundance. It was still less abundant in 1960, and was uncommon in many places in 1961. For example, a single specimen was collected from the low marsh community at Station J and at Station L, and a single specimen from the rocky shore at Station H. Only the rocky shore of Station R was found to have the expected large population of this species. It is no longer common in the low marshes generally, and is now for the most part confined to local rocky shores. *L. obtusata* Linn was somewhat less abundant during 1956-1961 than during the earlier period of study.

Melampus lineatus Say has spread over the marshes in the intertidal areas of the Annisquam Inlet and is generally more abundant in many places than in former years. A similar spread and increase for *Nassarius obsoletus* has been indicated earlier. On the other hand, *Nassarius trivittatus* Say was dredged less often in the Annisquam channel in 1956-1961.

Thais lapillus (Linn) has increased generally throughout the Annisquam Inlet since the earlier records of 1933-1937. In this connection I quote from a letter of J. Henry Blake, written in 1920, concerning the abundance of this species compared to that of *Littorina littorea* at Provincetown: "*L. littorea* has taken the place of *P. lapillus (Thais lapillus)*, which at one time was generally plentiful while now they are almost rare. The piles and rocks of the once many wharves being gone, their habitat, and they cannot live on the sand, it is also a cause." The same interchange was noted at Cape Ann in 1933 when *T. lapillus* virtually disappeared and *L. littorea* was exceedingly abundant. However, it cannot be claimed, as Blake thought, that *L. littorea* takes the place of *T. lapillus,* since the former is an herbivore and the latter a carnivore. They occur together in the same habitat, but do not compete with each other. These are examples of two independent population fluctuations occurring simultaneously in the same community.

Modiolus demissus (Dillwyn) and *Ensis directus* (Conrad) were more abundant during the years 1956-1961, while *Macoma balthica* (Linn), *Petricola pholadiformis* Lamarck, *Gemma gemma* (Totten), and *Tellina agilis* Stimpson were much less common during the later years.

According to George Gleason, a clam dealer at Gloucester, the soft-shelled clam *Mya arenaria* reached the lowest level of abundance in the years 1952-1953. Since then the clam has been increasing at Cape Ann. The clam diggers at Essex had their best season since 1931 in 1957.

Russell (1839) reported that *Solemya velum* was "very rare" in the Cape Ann area. This species has been a common one in the intertidal mud flats of Cape Ann, at least during the period of 1933-61, over which time the writer has made many collections.

V. Species Formerly Reported But Not Found in Recent Years.

1. The following species have been reported for Cape Ann by Russell (1852); Gould-Binney (1870); Morse (1909); and Johnson (1915). However, they were not collected by either the writer or by Clarke in recent years:

Anatina papyracea (now *Periploma papyratium*). *Philine quadrata*. *P. formosa*. *Doto coronata* (now *Idulia*). *Rissoa eburnea*. *Tagelus divisus*. *Turritella erosa* (now *Tachyrhynchus erosum*). *T. acicula* (now *Turritellopsis acicula*). *Tergipes despectus*. *Adeorbis costulata*. *Margarites olivacea*. *Coryphella rufibranchialis*. *Taonius pavo*. *Rossia hyatti*. *R. sublaevis*.

2. The following species were not found in 1956-1961, but had been collected by the writer in previous years:

Siliqua costata (shells only 1956-61). *Cingula aculeus*. *Mulinia lateralis*. *Anomia simplex*. *Lyonsia hyalina*.

VI. Miscellaneous Records.

The record for *Aeolis* sp. (Dexter, 1947) should be listed as *Aeolidia papillosa* (L.). A very large population of *Littorina saxatilis* and *Melampus lineatus* was destroyed in a large area of marsh land at the north end of the Annisquam Inlet in 1959. At that time sediment from the dredging of Lobster Cove was dumped upon the marsh as a ready means of disposal and to enlarge the adjacent Wingaersheek Beach.

Crepidula fornicata, *C. plana*, *Nassarius obsoletus*, and *Petricola pholadiformis* have for many years been far more abundant on Cape Ann than the report by Clarke (1954) would indicate. These species have been collected often by the writer from shoreline sampling and by dredging in shallow water.

Mercenaria mercenaria (L.) was introduced into the Annisquam River by R. M. Jones in 1955 who liberated about a dozen specimens obtained from Hadley's Harbor south of Cape Cod. A few survived each year for the following two years, and at

Arion subfuscus (Draparnaud)

least two survived over a period of three years.

In past years *Crassostrea virginica* (Gmelin) had been introduced into Goose Cove by several different people, but without success. In 1959 the Massachusetts Division of Marine Fisheries attempted to introduce this oyster into waters of Cape Ann. This introduction was reported to be successful through the first season.

Phacoides filosus (Stimpson) has not been collected alive in recent years at Cape Ann. In addition to shell records found earlier, another shell was collected 22 August 1959 by dredging in Gloucester Harbor. This is the first shell record from the location.

Yoldia thraciaformis (Storer) was reported by Clarke (1954) on the basis of a fish stomach specimen. This species has been dredged from Gloucester Harbor by the writer in recent years.

Neither Clarke nor the writer has collected living specimens of *Mesodesma arctatum* (Conrad). Both of us have collected shells on Good Harbor Beach which are so common it would seem reasonable that living specimens should be in the area.

Crenella glandula (Totten) was reported by Clarke (1954) from fish stomachs obtained from deep water. This same species was recovered by the writer from the stomach of a yellowtail flounder captured at entrance to Gloucester Harbor in August, 1959.

The ship worm *Teredo navalis* L. is probably more abundant in the area than collections would indicate. At the Montgomery boat yard wood removed from local boats has been seen on many occasions riddled with the tubes of Teredo. They have also been found in Lobster buoys and traps which have been washed ashore.

Specimens of *Xylophaga atlantica* Richards were seldom collected, but probably are more common than is realized. In March, 1958, John Auditore gave to the writer numerous specimens removed from a log which had been dredged from a depth of 30-40 fathoms some 10-15 miles out of Ipswich Bay. These specimens were given to the Department of Mollusks at the Museum of Comparative Zoölogy.

Literature cited

Abbott, R. T. 1954. American seashells. 541 pp.

Bequaert, J. C. 1943. The genus *Littorina* in the western Atlantic. Johnsonia no. 7. 27 pp.

Clarke, A. H. Jr. 1954. Naut. *67:* 112-120.
Dexter, R. W. 1942. Naut. *56:* 57-61.
—— 1944. Naut. *58:* 18-24.
—— 1945a. Naut. *58:* 135-142.
—— 1945b. Naut. *59:* 69-70.
—— 1947. Ecolog. Monogr. *17:* 261-294.
—— 1956. Naut. *69:* 140-141.
—— 1961. Naut. *75:* 85-86.
Gould A. A. (Edited by W. G. Binney). 1870. Report on the Invertebrata of Massachusetts. 524 pp.
Johnson, C. W. 1915. Fauna of New England. List of Mollusca. Occ. Papers Boston Soc. Nat. Hist. 7 (13): 1-231.
Morse E. S., 1909. Naut. *22:* 95.
Russell, J. L. 1839. J. Essex Co. Nat. Hist. Soc. *1:* 42-76.
—— 1852. J cit. *3:* 126-133.
Townsend, C. W. 1905. The birds of Essex County. Mem. Nuttall Ornith. Club *3:* 352 pp.

COLOR FORMS OF ARION SUBFUSCUS IN NEW HAMPSHIRE

By LOWELL L. GETZ, University of Connecticut

In a previous paper (Getz, 1962) I listed some locality records of *Arion subfuscus* (Draparnaud) in New Hampshire. Later collections made at 2 of the previously listed localities (8 miles N.W. North Woodstock and 2 miles N.E. Compton) have revealed certain facts concerning the color of this species in New Hampshire that are of interest.

Two distinct color phases of *A. subfuscus* are present in New Hampshire (Plate 5). One resembles the typical form in having dark black lateral lines, the other has only a trace of such lines. In addition, the back of the specimens with indistinct bands ranges from cream-buff to orange; that of the dark banded form is light cream color mottled with black pigment. No intergrade has been found between the 2 forms; the differences are distinct even in newly hatched individuals. Forty-seven specimens of the banded form were collected from 3 localities (8 miles N.W. North Woodstock, 2 miles N.E. Campton and 6 miles S. Gorham), 48 of the unbanded form were taken from 2 sites (8 miles N.W. North Woodstock and 1 mile N. Pequaket). Six egg masses were also obtained at the locality at which both color forms were present. When hatched in the laboratory, 3 of the egg masses yielded only banded individuals, 2 only unbanded forms, while

both banded and unbanded (8 and 4 respectively) were obtained from one.

Specimens of both color forms were sent to Dr. C. O. van Regteren Altena of the Rijksmuseum van Natuurlijke Historie, Leiden, Netherlands, for identification. From anatomical studies he found that both belonged to *Arion subfuscus*. The occurrence of both color forms in one egg mass confirms this identification.

Unbanded forms occur throughout Europe and do not appear to be rare; in certain areas intermediate forms occur, while in others there appears to be a definite dimorphy (C. O. van Regteren Altena, personal communication). Many of these color forms have been given variety or specific names (see for example Oakland, 1922; Simroth, 1885; Taylor, 1905-6. Pilsbry (1948) has reported unbanded forms from the United States (near Haverford, Pennsylvania); he stated that they were referable to the color varieties *alba* Esmark or *succinea* Bouillet. The color of the unbanded New Hampshire specimens resemble the descriptions of those from Pennsylvania. No comparable specimens of these forms or those from Europe were available; therefore, I could not determine to what color form the New Hampshire specimens belong.

Summary

Two distinct color forms of *Arion subfuscus* have been collected from New Hampshire. One resembles the typical form in possessing dark bands; the other has only faint traces of lateral bands. Both color forms were obtained from a single egg mass.

References

Getz, L. L. 1962. Nautilus *75:* 25-28

Oekland, F. 1922. Arionidae of Norway. Videnskaps. Skrifter. 1 Mat.-Naturv. Klasse *5:* 1-62.

Pilsbry, H. A. 1948. Land mollusca of North America. Monogr. Acad. Nat. Sci. 3, Vol. 2, pt. 2: 521-1113.

Simroth, H. 1885. Zeit. Wiss Zool. *42:* 203-336.

Taylor, J. W. 1905-6. Monograph of the land and fresh water mollusca of the British Islands. *2:* 161-280.

AMERICAN MALACOLOGICAL UNION MEETINGS, 1962

The American Malacological Union and its Pacific Division held summer meetings in 1962, both well attended and as always an unqualified success.

The Pacific Division met at Asilomar near Monterey, Cali-

fornia, June 27-30. Robert W. Talmadge presided as Chairman while these papers were heard: "The genus *Olivella* in the eastern Pacific," John Q. Burch. "The chiton family of Guadalupe Island," Allyn G. Smith. "A statistical study of *Conus perplexus* Sowerby and *Conus ximenes* Gray," Fay Wolfson. "Comparison of two rare cowrie species," Crawford N. Cate, "Systematics of Indo-Pacific Conidae," Alan J. Kohn. "A taxonomic problem in the ocenebras," E. P. Chace. "A few notes on the intertidal zonation of the west Mexican coast," Eugene Coan. "Plan for an illustrated handbook on west American prosobranch gastropods," James H. McLean. "Random notes on *Littorina newcombiana* Hemphill," Robert W. Talmadge. "Small pelecypods: how to identify them," A. Myra Keen. "Mollusks of Cocos Islands," Leo G. Hertlein. "Before Linnaeus," A. Myra Keen.

The following officers were elected to serve the Pacific Division in 1962-1963: Chairman, Crawford N. Cate. Vice-chairman, A. Myra Keen. Secretary, Ruth French. Treasurer, Fay Wolfsch. The 1963 meeting will be held in June, at Santa Barbara, California.

The American Malacological Union had accepted the invitation of co-hosts South Presbyterian College and the St. Petersburg Shell Club, to meet in St. Petersburg, Florida. The college provided the opportunity to meet, eat and sleep beneath one roof; and the club members, the hard work necessary to launch and conduct a 4-day meeting.

From July 31st through August 3rd, with President William K. Emerson in the chair, these papers were presented: "Shells of Tampa Bay," Lulu B. Seikman. "Living mollusks photographed by Theophil Kuczynski," Florence Kuczynski. "Mussel distribution in relation to stream confluence in northern Michigan," Henry van der Schalie (read by George M. Davis). "Small beginnings," Adlai B. Wheel. A theoretical model for measuring secondary productivity in mollusks," George M. Davis. "Comparative generic affinities of the sphaeriid clam genus *Eupera* Bourguignat, 1845," William H. Heard. "Water in mantle cavity of land snails," Walter C. Glen. "The systematic position of the family Caecidae," Donald R. Moore. "Collecting fresh-water snails in Florida," Richard I. Johnson. "Notes on the classification of fresh-water limpets," John Bayard Burch. "The genus *Latiaxis* in Japan," Anthony D'Attilio. "Shell boring habit of *Capulus danieli*," Virginia Orr. " 'Brainwash' experiments with

mollusks," Henry E. Coomans. "Nest building in *Musculus*," Arthur S. Merrill. "Fossil shells of Florida," Edna Marcott. "What is *Cypraea arabica niger*?" William E. Old, Jr. "Cuba, a lost shell paradise," M. K. Jacobson. "*Rochefortia*—a new record in Tampa Bay," J. P. E. Morrison. "Fresh-water mollusks of Georgia," William J. Clench. "Triphoridae of the Florida Gulf Coast," Dan Steger. "Report of the San Diego Museum Expedition to the Vermillion Sea, Gulf of California," William K. Emerson.

Highlights of the meetings were the fish fry which the St. Petersburg Shell Club provided for their guests the first evening, the luau-style banquet at a Polynesian-style restaurant, and an all-day collecting trip to one of the famous shelling beaches of Tampa Bay.

The 1963 meeting will be held at the Museum of Science, in Buffalo, New York. The officers elected to serve in 1962-1963 are: President, Albert R. Mead. Vice-president, John Q. Burch. Second Vice-president, Crawford N. Cate. Secretary, Margaret C. Teskey. Treasurer, Jean M. Cate. Publications Editor, M. J. Jacobson. Councillors-at-Large, Bernadine Baker, Arthur H. Clarke, Jr., Dee Dundee, Donald R. Moore.

— Margaret S. Teskey, Secretary.

OLIVE HORNBROOK MACFARLAND
1872-1962

On May 1, 1962, Mrs. MacFarland died at Stanford University at the age of 90 after an illness of several months. During her college career she took a course under Prof. Frank Mace MacFarland, the most active American worker on Nudibranchia for many years. Her master's thesis (unpublished) was on a species of this group from the west coast. In preparing this, it developed that she had unusual talent in drawing the living animals in color as well as the anatomical details in black and white.

After they were married she illustrated the most important of Dr. MacFarland's papers on the Nudibranchia. For many years he had in preparation a monographic study of the west American species of this group but at the time of his death in 1951, it was unfinished. From then until her death she labored constantly in trying to put the manuscript and notes in form for publication. It may be that she accomplished her purpose. In

this work there are approximately 80 plates, 35 of them done in beautiful water colors.

The anatomical drawings are done by a technique which she perfected to an amazing degree. They are done with "crayon sauce" and brushes.

Since illustrations are as important as text in most taxonomic publications on mollusks, it is believed that conchologists owe this slight tribute to the artist, Olive H. MacFarland.

—G. Dallas Hanna.

NOTES AND NEWS

Additions to Teton County, Wyoming, Mollusca.—Field work in the Grand Teton National Park during the summer of 1961 has disclosed two species of mollusks previously unreported for Wyoming, and nine species to be added to the Teton County list.

The state records are as follows:

Vertigo elatior Sterki: Moran Junction, aspen grove, under leaves.

Pisidium obtusale Pfr. var. *robusta:* Small lily pond south of Arizona Lake, collected by D. W. Taylor & D. E. Beetle; Bay east of Berol Ranch; pond on Signal Mt., all in mud.

County records are as follows:

Vertigo ovata Say: Pacific Creek pond #1, in moss.

Sphaerium striatinum (Lam.): Pacific Creek pond #1, in mud and moss at edge of pond.

Pisidium compressum Prime: Snake River near Wilson, swampy area along the river: Snake River near Flagg Ranch, swampy.

Galba parva (Lea): Moran Junction, swampy area in aspen, on *Juncus.*

Gyraulus circumstriatus (Tryon): Pacific Creek pond #1, on moss and plant roots.

Gyraulus parvus (Say): Oxbow of the Snake River; Third Creek.

Armiger crista (L.): Pacific Creek pond #1, in moss at edge of pond, Third Creek, on aquatic vegetation.

Promenetus exacuous (Say): Third Creek; pond south of Arizona Lake; Pacific Creek #1, in moss at edge of pond.

Physa skinneri Taylor: Gros Ventre pond, east of Slide Lake; Pacific Creek pond #2; Signal Mt. pond, pond south of Arizona Lake.—Dorothy E. Beetle.

On south Atlantic Columbellidae.—The southern limit in the range of *Anachis obesa* (C. B. Adams) is on the coast of Rio

THE NAUTILUS

Vol. 76 January, 1963 No. 3

BATHYMETRIC AND GEOGRAPHIC DISTRIBUTION OF PANOPEA BITRUNCATA

By ROBERT ROBERTSON
Assistant Curator of Mollusks,
Academy of Natural Sciences of Philadelphia

Although considered rare, the large shells of *Panopea bitruncata* (Conrad, 1872), one of two eastern American species in the genus[1] (family Hiatellidae ["Saxicavidae"]), have long been known from the beaches of North Carolina, and from the Atlantic and Gulf coasts of north Florida. Following C. W. Johnson's suggestion (1929, p. 85) that this bivalve might be locally extinct, Abbott (1954) stated that possibly it was wholly so. The latter supposition was negated when Pope (1955) and M. C. Johnson (1956) reported the discovery of a live specimen in intertidal mud at St. Augustine, northeast Florida (Fig. 1, locality 3).

Panopea normally lives with its shell deeply buried in mud or sand, with the fused, elongate siphons extending to the surface of the substratum. Evidence is presented in this paper which suggests that a *P. bitruncata* dislodged during a storm could not rebury itself and remained alive loose on the surface of the substratum for 3 months.

Other information on *P. bitruncata* which has been accumulated since the publication of M. C. Johnson's (1956) paper is also presented here. *P. bitruncata* has been obtained alive at 4 other localities during and since 1956. The known bathymetric range is extended from near low water down to 26 fathoms, and the known geographic range is extended to southern Texas. Hitherto, the species has not been reported west of Mobile Point, "Mississippi" [actually Alabama; see Fig. 1] (Dall, 1898; C. W. Johnson, 1904).

---

[1] *P. abbreviata* Valenciennes ranges from 47° 46′ S., southern Argentina (Carcelles, 1944), north to Rio de Janeiro (23° 00′ S.), Brasil (Lange, 1949). On taxonomy of whole genus, see Lamy (1925).

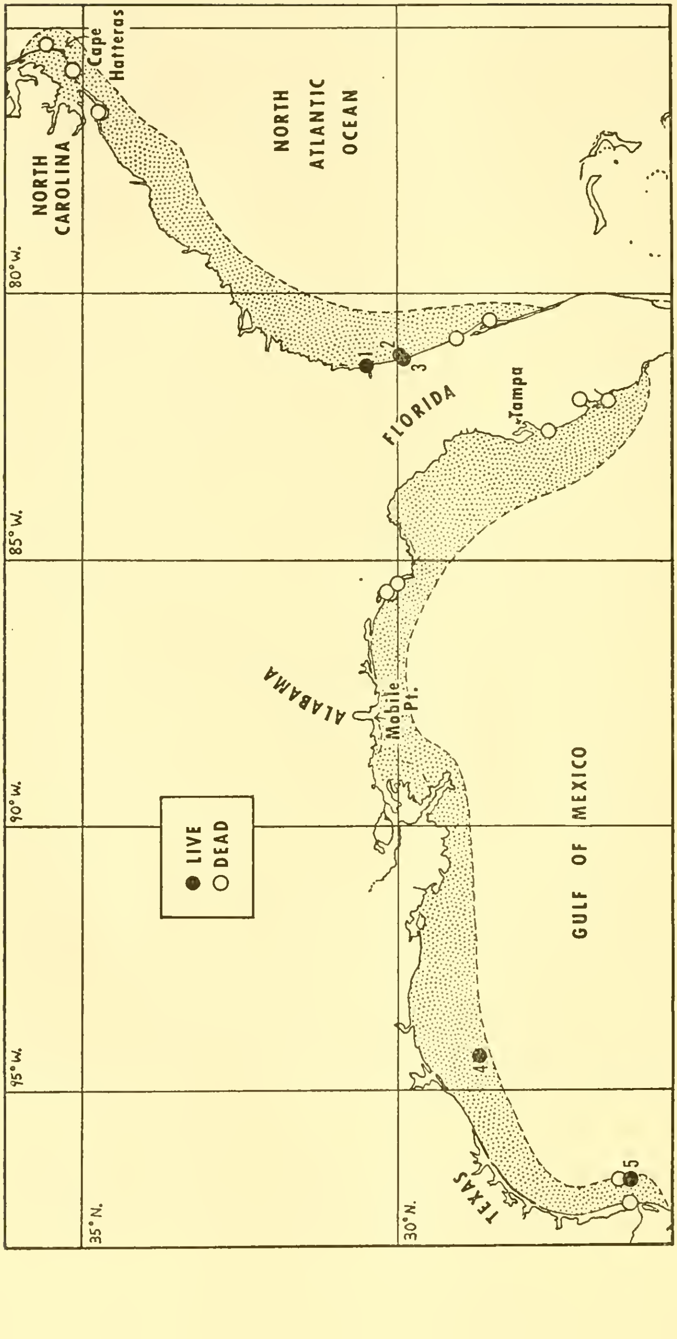


Fig. 1. Recent distribution of *Panopea bitruncata* (Conrad)

Localities where *P. bitruncata* has been collected are plotted on the accompanying map (Fig. 1). Numbered spots indicate localities where specimens have been obtained alive. Circles indicate the additional localities where presumed non-fossil shell valves have been collected. Most of the latter are at The Academy of Natural Sciences of Philadelphia (A.N.S.P.), United States National Museum (U.S.N.M.), and Museum of Comparative Zoology (M.C.Z.).

For illustrations of *P. bitruncata,* see C. W. Johnson (1904), M. C. Johnson (1956), and (abnormal shell) Conrad (1872).

Reasons for spelling the generic name *Panopea* rather than *Panope* (prevalent in American literature) are given by Vokes & Cox (1961).

Locality records and observations. I. *Living Specimens.* A. *Northeastern Florida.* 1. On July 29, 1961, a single live specimen was collected by Mr. H. Mace Stephens from black, oozy mud in very shallow water at Fort George Inlet, near Jacksonville (Fig. 1, locality 1). (Anon., 1961.)

2. On July 19, 1956, the collecting crew of the Marineland Research Laboratory dredged a specimen in 12 fathoms, about 9 miles northeast of St. Augustine Inlet (locality 2). The specimen was generously donated to The Academy (A.N.S.P. no. 205817) by Mr. F. G. Wood, Curator at the Laboratory. The body of the animal is preserved in alcohol; the shell valves are in the dry collection. The shell is thin and fragile; the left valve is 11.4 cm. long and 7.4 cm. high (right valve broken).

This specimen is noteworthy in two respects: (i). The periostracum on the fused siphons is arranged in annular, wavy bands, with lamellar projections as high as 6 mm. irregularly concentrated along the dorsal surface and left side. Siphonal periostracum of specimens from localities 3 and 4 is wrinkled but there are no lamellar projections. (ii). There are small barnacles on the exterior of each of the shell valves, and a few also on the mantle and siphonal periostracum. These barnacles were present when the animal was dredged (*fide* F. G. Wood). All are *Balanus* (*Balanus*) *amphitrite niveus* Darwin, which occasionally attains a diameter of 10-12 mm. and which is known from low water down to about 30 fathoms (Pilsbry, 1916). The barnacles are concentrated at the antero-ventral portions of each shell valve

and are absent from the umbonal areas. In carino-rostral diameter, the barnacles range from 0.6 to 2.4 mm. and average 1.4 mm. (131 measured on left valve; 48 on right).

Had this *Panopea* lived with the shell deeply buried, barnacles could not have settled on it. The presence and position of the barnacles indicate that the *Panopea* rested on the dorsal portion of its shell, lying loose on the surface of the substratum for at least several weeks. The barnacles on the shell could have attained a diameter of 2.4 mm. in 1-3 weeks, assuming the maximum probable growth rate. Assuming the minimum rate, the barnacles could have grown for a much longer time. (Extrapolations from published data on the summer growth rate of *Balanus amphitrite* in shallow water at Hawaii (Edmondson & Ingram, 1939; Edmondson, 1944) and near Miami, Florida (Smith *et al.*, 1950), with allowances for a slower growth rate in 12 fathoms and for the larger size of the Hawaiian subspecies.)

To explain the abnormal position in life of this *Panopea,* I suggest that it was dislodged from its burrow during the unusually intense cyclonic storm which passed over St. Augustine April 10-11, 1956 (McQueen & Rammer, 1956), and that it lived loose on the bottom for 3 months until it was dredged (July 19). The lamellar projections on the siphons might normally be abraded when the siphons are drawn up and down the burrow.

3. See M. C. Johnson (1956) and Pope (1955).

B. *Texas.* 4. In July, 1961, several specimens were dredged by shrimp fishermen from 17-25 fathoms near some oil rigs off Galveston Island (locality 4). One of these remained alive 5 days out of water. Mr. W. C. DeWitt (Freeport), who preserved the animal by injecting formalin, kindly loaned for study his shell containing the dried animal. This shell is 17.7 cm. long, 11.9 cm. high, and the 2 valves (closed) are 8.6 cm. wide. According to Mr. DeWitt, the partially contracted siphons extended 7½ ins. (19 cm.) beyond the posterior end of the shell. The present locations of the other specimens are unknown. Mr. DeWitt has suggested that they all were dislodged from mud by the oil drilling activities.

5. According to Dr. Thomas E. Pulley (letter dated May 8, 1962), shells "are not uncommon in collections from the Port Isabel area. . . . There is one specimen there that was taken alive

by a shrimper when his boards buried in a mud lump. . . ." According to Betty Allen (letter dated May 28, 1962), this live specimen was obtained by her husband from 26 fathoms due east of the Port Isabel Bar (locality 5).

II. *Dead Specimens. A. North Carolina.* Except for one occurrence, *P. bitruncata* is known exclusively from the Carolinian faunal province. One pair of recently dead shells has been obtained in the Virginian faunal area, part of the Boreal province (see Coomans, 1962), about 20 miles north of Cape Hatteras (Fig. 1) which is the northern boundary of the Carolinian province. This specimen was dredged from an unrecorded depth by a trawler southeast of Wimble Shoal (opposite Rodanthe), Nov. 1958 (American Mus. Nat. Hist. no. 85984, from F. W. Watson).

Mrs. Z. W. Craine collected a pair of shells containing remains of soft parts in late September, 1959, after a severe storm (washed ashore about 25 miles W.S.W. of Cape Hatteras: Atlantic beach S. end Ocracoke Island).

Beaufort (U.S.N.M.); Fort Macon (holotype A.N.S.P. no. 51116 [pair]; topotype A.N.S.P. no. 148105).

B. *Northeastern Florida.* St. Augustine (U.S.N.M.; M.C.Z.); Coronado Beach (M.C.Z.); Cape Canaveral (M.C.Z.).

C. *Western Florida.* Sanibel Island (M.C.Z.; McLean, 1936); Punta Gorda Beach (A.N.S.P.); Sarasota Bay (U.S.N.M.); Tampa (Maury, 1920).

D. *Northwestern Florida.* Crooked Island, off St. Andrew Sound (A.N.S.P.; Vanatta, 1904); Hurricane Island, off Panama City (U.S.N.M.); Panama City (A.N.S.P.).

E. *Alabama.* Mobile Point (Dall, 1898, as *P. floridana* Heilprin).

F. *Texas.* Shell valves have been collected on the beach of South Padre Island and a pair in poor condition has been trawled by a shrimp fisherman from about 30 fathoms northeast of Port Isabel (*fide* T. E. Pulley ancd Betty Allen).

Conclusions

Panopea bitruncata occurs alive from the lower intertidal zone down to a depth of at least 26 fathoms. Hitherto, the genus appears not to have been reported alive at such depths, although dead *Panopea* shells are known from 60-70 fathoms (Powell, 1950). Seemingly, the only prior records of *Panopea* occurring

alive below the tidal zone are those of Navaz y Sanz (1946) and of Cotton (1961), who mention (respectively) *P. glycimeris* (Born) from 1-2 fathoms (depth estimated from H.O. chart 4398) and *P. australis* Sowerby from 7-8 fathoms. Most reports of live *Panopea* concern specimens dug in the lower intertidal zone, where they are most readily collected (Valenciennes, 1839; Lowe, 1933; Milne & Milne, 1948).

Panopea may usually be a subtidal bivalve. Specimens rarely would be obtained alive below the tidal zone because of the depth at which they normally live buried. Living subtidal specimens perhaps have all been obtained under exceptional circumstances.

P. bitruncata can be expected wherever there are suitable substrata in the stippled area in Fig. 1. Locally, it may be fairly abundant below the tidal zone because shell valves (many of them admittedly worn or subfossil) slowly accumulate on Carolinian, Floridian, and Texan beaches. The known distribution now coincides with the extent of the Carolinian faunal province, except for one occurrence in the southern part of the Boreal province.

There are numerous fossil species of *Panopea;* they range back in age perhaps to the mid-Jurassic (Cox, 1946). Believing that living species in the genus are relicts, some malacologists have claimed that there have been extinctions during or since the Pleistocene epoch. For example, Barnard (1952?) states that a South African *Panopea, P. natalensis* Woodward, is "not living at the present day" but that it occurs "as a fossil in Pleistocene raised beaches around the coast."[2] In view of the negation of a similar suggestion made in 1954 regarding *P. bitruncata,* all such claims are perilous. *P. natalensis* (s.s.) was once obtained alive shortly prior to 1839 (Valenciennes, 1839; Woodward, 1856).

Acknowledgments. The following persons kindly provided information: R. T. Abbott, Betty Allen, Z. W. Craine, W. C. DeWitt, W. E. Old, Jr., T. E. Pulley, J. Rosewater, Mildred Tate, R. D. Turner, and F. G. Wood, Jr.

---

[2] Hoepen (1940) has claimed that the South African Pleistocene fossils are a different species, which he named *P. dreyeri. P. natalensis* was first collected in southern Angola, not Natal (Winckworth & Winckworth, 1935). *P. natalensis* and *P. dreyeri* closely resemble *P. glycimeris* which, according to Nickles (1950, as *P. aldrovandi* Menard), ranges south to Dakar, Senegal.

References

Abbott, R. T. 1954. American Seashells, p. 454.

Anonymous 1961. The Shell-o-gram (Jacksonville Shell Club), *2* (8): 1. Mimeogr.

Barnard, K. H. 1952? A Beginner's Guide to South African Shells, 2nd. ed., p. 167.

Carcelles, A. 1944. Rev. Mus. La Plata, ser. 2, Zool., *3:* 294, pl. 14, fig. 114.

Conrad, T. A. 1872. Proc. Acad. Nat. Sci. Philadelphia, *24:* 216, pl. 7, fig. 1.

Coomans, H. E. 1962. Beaufortia, *9* (98).

Cotton, B. C. 1961. South Australian Mollusca; Pelecypoda, pp. 304-305.

Cox, L. R. 1946. Proc. Malac. Soc. London, *27:* 30-31.

Dall, W. H. 1898. Trans. Wagner Free Inst. Sci. Philadelphia, *3* (4): 831.

Edmondson, C. H. 1944. Occ. Pap. B.P. Bishop Mus., *18* (1): 16-23.

Edmondson, C. H. & W. M. Ingram 1939. *Ibid., 14* (14): 257-264.

Hoepen, E. C. N. van 1940. Tydskrif vir Wetenskap en Kuns (Bloemfontein), ser. 2, *1* (2): 185-193, pls. 10-11.

Johnson, C. W. 1904. Naut., *18:* 73-75, pl. 4.—1929. *Ibid., 42:* 82-85.

Johnson, M. C. 1956. *Ibid., 69:* 121-123, pl. 8.

Lamy, E. 1925. J. Conchyl., *68:* 266-279.

Lange de Morretes, F. 1949. Arq. Mus. Paranaense, *7:* 47.

Lowe, H. N. 1933. Naut., *47:* 46.

Maury, C. J. 1920. Bulls. Amer. Paleo., *8* (34): 142 (110).

McLean, R. A. 1936. Naut., *49:* 104.

McQueen, H. R. & W. A. Rammer 1956. Monthly Weather Review (U.S. Weather Bureau), *84* (4): 166-178 (see also Chart X).

Milne, L. J. & M. J. 1948. Natural History, *57* (4): 162-167, 190, figs.

Navaz y Sanz, J. M. 1946 ["1945"]. Bol. R. Soc. Espanola Hist. Nat., *43:* 365-368.

Nickles, M. 1950. Moll. Test. Marins Cote Occid. Afrique, p. 228.

Pilsbry, H. A. 1916. Bull. U.S. Natl. Mus., *93:* 92-96.

Pope, V. A. 1955 ["1954"]. Quart. J. Florida Acad. Sci., *17:* 252.

Powell, A. W. B. 1950. Rec. Auckland Inst. Mus., *4:* 77-79.

Smith, F. G. W., R. H. Williams & C. C. Davis 1950. Ecology, *31:* 138.

Valenciennes, A. 1839. Arch. Mus. Hist. Nat. [Paris], *1:* 1-38, pls. 1-6.

Vanatta, E. G. 1904 ["1903"]. Proc. Acad. Nat. Sci. Philadelphia, *55:* 756-757.

Vokes, H. E. & L. R. Cox 1961. Bull. Zool. Nomencl., *18:* 184-188.

Winckworth, H. C. & R. 1935. J. Conchol., *20:* 162.
Woodward, S. P. 1856 ["1855"]. Proc. Zool. Soc. London, *23:* 218-221.

VARIATIONS IN THE ANATOMY OF THE SUCCINEID GASTROPOD OXYLOMA RETUSA

By DOROTHEA S. FRANZEN
Biology Department, Illinois Wesleyan University

In North America, the family of Succineidae is represented by the genera *Oxyloma* Westerlund, *Succinea* Draparnaud, and *Catinella* Pease (*Quickella* C. Boettger) (Pilsbry, 1948, p. 775). The shells of these genera are generally fragile, amber colored, ovate, imperforate and consist of up to four whorls. The spire is short, the aperture large, ovate and bounded by a sharp peristome.

At first, the systematics of gastropod mollusks generally were based upon shell characters. This method has been satisfactory in the treatment of gastropods whose shells have distinctive features as those, for example, of the Pupillidae. Subsequent studies of the soft anatomy of the Pupillidae (Steenberg, 1925) and of North American Pupillidae (Baker, 1935) have done very little more than confirm the taxonomic variations which previously were based essentially on shell characters.

The shells of the Succineidae lack specific features such as color patterns, ridges or distinctive lamellae and folds within the aperture. Traditionally the systematics of the group have been based on shell characters such as relative size and shape of the shell, size and shape of the aperture, which all have since proved to be not specifically nor sometimes even generically distinctive. Therefore, a great deal of the systematics within this family are in a state of error and confusion.

Quick's (1935) careful study of the anatomy of the British Succineidae brought to the attention of the malacologists the existence within this family of the differentiating characteristics of anatomical structures such as the genitalia and to a certain degree the genital apertures, radulae, jaws, and pigmentation of the body and mantle, and thereby introduced the employment of such characteristics in the systematics of the Succineidae. Further systematic studies of the family have been based on

Quick's method. Boettger (1939), in his study of the German *Succinea,* described the genus *Quickella,* separating it from *Succinea* Draparnaud on the basis of the structure of the male genitalia. Pilsbry (1948) included, admittedly to a limited extent, anatomical features along with shell characters in his treatment of Succineidae in North America. Odhner (1950) revised the systematics by erecting the subfamily Catinellinae and establishing the taxonomic categories within the subfamily on characteristics of the respective genitalia, along with the radulae.

Continued studies of Succineidae in the United States have further demonstrated that the employment of characteristics of the soft anatomy, especially those of the genital systems, radulae, jaws and features of the external body wall is essential in the systematics of this family. Lee (1951) in describing *Succinea vaginacontorta* used chiefly anatomical features in his systematic treatment. Webb (1953, 1954) in studying the systematics of succineids in midwestern United States found the anatomical structures to be useful and the shell structures essentially unreliable. Miles (1958), in his classification of the Succineidae in Kansas, employed chiefly the characteristics of the genitalia, which he found to be distinctive, rather than the shells which lack reliable generic as well as specific differentiating features (p. 1500). Franzen (1959) described anatomical features of the North American species *Succinea ovalis* Say (the type of *Novosuccinea*) which distinguish it from the European *Succinea putris* (Linné).

The extent to which anatomical characters of species within a genus may be used successfully as a guide to systematic relationships is dependent, however, upon sound knowledge of the nature and degree of variations that may exist among the members of a freely interbreeding local population, or among disjunct populations of the same species. Without information concerning the nature and degree of individual and geographical variation within a population or in a series of populations, anatomical data cannot be employed in full confidence.

The results of studies made of anatomical variations occurring in *Oxyloma retusa* are herein described. The purpose is to establish the extent of variation in this particular species and thus to be able to use the degree of variation as a standard for further

comparative studies among North American species of the Succineidae. Because, among the several organ systems, the reproductive organs are regarded as the most sensitive to selection pressure, variations in their anatomy have been emphasized. Variations in other features, including those of the shell, jaw, radula and external features of the animal such as pigmentation of the body and mantle, are also considered and data are presented. The author's intention is to note variations within a population as well as the geographical ones.

To obtain information regarding variation within a population, the individual collections were restricted to an interbreeding population in a single, small, well-defined habitat. To note geographical variations, collections were made from 11 stations whose range extended from northwestern Minnesota (Station 1) to southwestern Kansas (Station 11) and east from northwestern Iowa (Station 7) and central Illinois (Station 8), west to southwestern Kansas (Station 11). The geographic range is large enough and the habitats differ sufficiently for the snails to exhibit variations possibly attributable to ecological conditions and/or genetic isolation. The collections were made in the months of May, June and July, from 1956 to 1961.

The collecting stations, together with brief descriptions of their local ecology, listed in a north to south geographic order are:

1. National Migratory Waterfowl Refuge, Mud Lake, Marshall County, Minnesota, about 120 mi. N. Itasca State Park. Snails lived on leaves of cattails growing in shallow water along the unshaded shores of large ponds.
2. Itasca State Park, Clearwater County, Minnesota. Snails lived among grasses on the wet unshaded shore of the Mississippi River, 200 yds. from its source in Lake Itasca.
3. Itasca State Park, Clearwater County, Minnesota. Snails lived among cattails growing in a depression formed by an ice bank on the shore of Elk Lake.
4. Meadow pond, Hubbard County, Minnesota, 10 mi. N.E. Itasca State Park. A growth of grasses and sedges afforded cover for the snails on the unshaded shore of the pond.
5. Waubun Prairie University of Minnesota Research Area, Mahnomen County, Minnesota, 40 mi. N. Lake Itasca. The habitat of the snails was among the sedges growing on the mudflat of the unshaded shore of a pothole pond.
6. Heron Lake, 0.5 mi. N. city of Heron Lake, Jackson County, Minnesota. A dense growth of cattails on the muddy and wet

shore of a large pond supported a large population of the snails.

7. Miller's Bay, west side of Lake Okobojie, Dickinson County, Iowa. Snails lived among and on the cattails growing on the muddy and wet shore of a large pond.

8. Two mi. E. Peoria, Tazewell County, Illinois, east side of U. S. Hgwy. 150. Snails lived among the cattails growing in a slough formed by drainage from a hillside.

9. One mi. S. White Cloud, Doniphan County, Kansas. The habitat was a growth of cattails on the flood plain of the Missouri River.

10. One and one-half mi. S. Muscotah, Jefferson County, Kansas. The habitat was an artesian spring-fed cattail swamp.

11. Meade County State Park, Meade County, Kansas. The snails lived among the cattails growing along the shore of a pond.

Procedure. The snails were relaxed and killed for dissection by a slow drowning process. This was achieved by placing a few individuals in a vial containing a dilute solution of sodium nembutal and ethyl alcohol and sealing the vial to exclude air. Snails to be used for later study were preserved in 70% alcohol.

A total of more than 150 bodies of snails and their shells were examined. All the snails studied were sexually mature and active although not all were fully grown. Scale drawings were made of the reproductive organs and also of radulae and jaws. The shell, drawings and correlated preserved and anatomical preparations from a single snail were catalogued with the same number in order to retain their identity.

Individual and Geographic Variations. Pilsbry (1948) in his study of the Succineidae includes a review of *Oxyloma retusa*. Shell measurements of several representative collections are given. Lea's type from near Cincinnati, Ohio, is 0.7 in. (17.9 mm.) in length and 0.3 in. (7.7 mm.) in diameter. Although Pilsbry does not give any measurements based upon *O. retusa* specifically, he gives (p. 787) measurements of 3 shells of *Succinea higginsi* Bland, which he considers "to be practically typical *retusa*", from Put-in-Bay Island, Lake Erie. The length varies from 15.5 to 16.3 mm., the diameter from 7.7 to 8.7 mm., and the length of the aperture from 11.6 to 12.0 mm. He also states that *Succinea retusa magister,* which he now considers synonymous with *O. retusa,* attains a maximum height of 18 mm., greatest width 9½ to 10 mm. and length of aperture 13 to 14 mm.

Pilsbry (p. 786) records his impression of *O. retusa:* "Typically

this species differs from *O. [xyloma] d. [ecampi] gouldi* by the larger size and the broader, more retracted and less deeply curved basal margin of the aperture. However, these are variable qualities; in some of the forms temporarily placed here as races of *retusa,* the basal arc of the peristome is rather deeply arched. The color is colonial buff."

Variations in shell structure. In most of the localities from which collections for this study were made, the snails were abundant so that a large series could be obtained. The data recorded in Table I are from the 3 largest shells selected from each of the stations.

The whorls are sharply incised and vary in number from 2½ to 3½. The surface is marked with irregularly spaced and oblique striae. The nuclear whorl is finely stippled and white in appearance. The ultimate whorl is large and terminates in an ovate aperture whose base is deeply arcuate and apex sharply pointed. The peristome is sharp and the callous very thin. Sometimes the columella emerges below the apex of the aperture and continues along the margin of the ultimate whorl in the form of a spiral plait.

The shells obtained from the localities included in this study exhibit a range in maximum height from 8.3 mm. (Station 4) to 19.8 mm. (Station 7). The shells from within Lake Itasca State Park (Stations 2 and 3) and nearby (Station 4) are the smallest. The largest shells are from stations: No. 6, Heron Lake, Minnesota; No. 7, Lake Okobojie, Iowa; and No. 9, White Cloud, Kansas. The shells of the intermediate size range are from stations: No. 1, Mud Lake, Minnesota; No. 5, Waubun Prairie, Minnesota; No. 8, Peoria, Illinois; No. 10, Muscotah, Kansas; and No. 11, Meade County, Kansas (Table I).

The height of the aperture ranges from 65.9 to 84 per cent of the total height of the shell. The height of the aperture varies from 5.5 mm., in the smallest shell here recorded, to 13.7 mm. in the cases of the shells whose total height are 19.8 and 18.4 mm. The largest aperture is not necessarily found in the largest shell. The width/height ratio of the shell varies from 46.7 to 60 per cent. Again, the aperture of greatest width cannot be correlated with the shell of the greatest width.

The width/height ratio of the aperture also varies notably.

The greatest height of the aperture here recorded is 13.7 mm. whereas its width is 6.9 mm. (width/height, 74.4 per cent). An aperture which measures 13.1 mm. in height measures 8 mm. in width (width/height, 71.9 per cent). Other ratios of various measurements are to be noted in Table I.

Table I

Measurements of Shells of Oxyloma retusa (Lea)

STATION	No. of Whorls	Height	Width	Width/ Height	Height of Aperture	Width of Aperture	H. of Ap. / H. of Shell	W. of Ap./ W. of Shell	W. of Ap./ H. of Ap.
1. Mud Lake	3	15.4 mm.	8.0 mm.	51.9 %	11.2 mm.	6.5 mm.	72.7 %	81.2 %	68.8 %
	3-1/4	14.5	7.3	50.3	10.5	6.5	72.4	75.3	52.3
	3-1/8	13.4	7.6	56.7	10.0	5.7	74.6	75.0	57.0
2. Mississippi River Headwaters	3	10.3	5.7	55.3	8.1	4.7	78.8	82.4	58.0
	3	9.2	4.8	52.1	7.1	4.2	77.1	87.5	59.1
	3	8.7	4.6	52.8	6.5	4.2	74.7	91.3	64.6
3. Elk Lake	3	13.5	7.8	57.7	10.8	5.6	80.0	71.7	51.8
	3	12.8	7.0	54.6	9.7	5.6	75.7	80.0	57.7
	3-1/4	12.7	7.0	55.1	10.1	5.4	79.5	77.4	53.4
4. Meadow Pond	2-3/4	8.3	4.7	56.6	6.1	3.6	73.4	76.5	59.0
	2-1/2	7.8	4.6	68.9	5.6	3.9	71.7	84.7	69.8
	2-1/2	7.4	3.7	50.0	5.5	3.1	74.3	83.7	58.3
5. Waubun Prairie	3-1/2	15.8	8.4	53.1	11.2	6.1	70.8	72.6	54.4
	3-1/8	13.2	6.7	50.7	8.7	5.1	65.9	76.1	58.6
	3-1/8	13.2	6.7	50.7	9.1	5.1	68.9	76.1	56.0
6. Heron Lake	3-1/4	18.4	9.2	50.0	13.7	6.9	74.4	75.0	50.3
	3-1/8	18.2	8.5	46.7	13.1	8.0	71.9	94.1	61.0
	3-1/8	18.2	9.3	51.0	13.2	7.2	72.5	77.4	54.5
7. Miller's Bay, Lake Okobojie	3-1/2	19.8	10.2	51.5	13.7	7.1	69.1	69.6	51.8
	3-1/4	18.6	9.0	48.3	12.6	7.2	67.7	80.0	57.1
	3-1/4	18.2	8.7	47.8	12.6	6.2	69.2	71.2	49.2
8. Peoria	3-1/4	14.9	8.3	55.7	11.3	7.2	75.8	88.7	63.7
	3	13.1	7.6	58.0	10.2	6.5	77.8	85.5	63.7
	3	12.5	7.2	57.6	9.8	5.8	78.4	80.5	59.18
9. White Cloud	3-3/8	17.5	8.5	48.5	12.3	6.7	70.29	78.8	54.4
	3-3/8	17.4	8.3	47.7	12.7	7.8	72.9	93.9	61.4
	3-3/8	17.3	8.9	51.4	13.1	7.4	75.7	83.1	56.4
10. One and one-half mi. S Musootah	3-1/8	15.0	7.7	51.3	11.7	6.6	78.0	85.7	56.4
	3-1/8	15.0	7.8	62.0	12.6	6.6	84.0	84.6	52.3
	3	13.8	7.7	55.8	11.3	6.8	81.8	88.3	60.1
11. Meade County State Park	3-1/4	15.5	9.3	60.0	12.4	7.5	80.0	80.6	60.4
	3-1/4	15.0	7.1	47.3	11.0	6.5	73.3	91.5	59.09
	3-1/8	12.5	7.3	58.4	9.8	5.1	78.4	69.8	52.0

The measurements are of the 3 largest shells of each of the 11 localities. In the 4th column of measurements are listed the ratios of the width of the shell over its height. In the last 3 columns are listed the ratios of the height of the aperture over the height of the shell; width of aperture over width of shell; width of aperture over height of aperture.

The distribution of the various size ranges, as noted above and recorded in Table I, does not indicate any relationship between the geographical distribution and the size of the shell. The larger shells are from localities to the north and south of the localities of the smallest shells (Lake Itasca State Park), as well as from localities to the east and west.

Variations in external appearance of the body. The body wall is light cream colored, finely and irregularly tuberculate, and peppered with flecks of black pigment. Over the dorsal surface of the head up to the posterior tentacles, the flecks occur in irregular patches. At the level of the posterior tentacles, the flecks are arranged in 3 not sharply defined bands The median dorsal band divides as it extends toward the mantle collar. It tends to become lighter as it approaches the collar and sometimes does not extend that far. The median band is flanked on either side by an equally wide band which extends to the mantle collar. The lateral body wall is pigmented by a broad band which becomes lighter ventrally and terminates above the ventral margin leaving a white band along the ventral border of the body wall corresponding in length to that of the foot. The mantle is generally darkly and uniformly speckled. Sometimes light blotches along the anterior margin produce a mottled or broadly striped effect. Through the mantle the kidney is seen as an orange band following the contour of the body. Frequently a darkly pigmented band on the mantle outlines the posterior margin of the kidney. The degree of pigmentation on the body wall and on the mantle is variable from very light to very heavy. A few very darkly pigmented (essentially black) individuals were found at the Mud Lake National Migratory Waterfowl Refuge (Station 1).

Towards the ventral margin, shallow vertical grooves incise the very shallow suprapedal groove and the pedal groove producing a series of shallow scallops along the ventral margin especially when the animal is in a partially contracted state. The genital aperture is a slit ranging in length from 0.6 to 0.9 mm. and is surrounded by an oval, white lip. In animals preserved in alcohol the lip appears less tumid in some individuals than in others.

Variations in the radula and jaw. The structure of the radula of *Oxyloma retusa* bears the general generic characteristics. It is comprised of from 70 to 112 rows of teeth. The number of teeth

Table II

Station	No. of Rows of Teeth	No. of Teeth in a Row	Tooth Formula
1. Mud Lake	112	(a) 93	C - 9 - 37
		(b) 93	C - 11 - 35
	96	103	C - 9 - 42
3. Elk Lake	87	(a) 81	C - 10 - 35
		(b) 95	C - 9 - 38
	70	87	C - 9 - 34
4. Meadow Pond	80	77	C - 7 - 31
5. Waubun Prairie	91	87	C - 11 - 32
7. Lake Okobojie	102	(a) 81	C - 9 - 31
		(b) 93	C - 7 - 39

Counts made of representative radulae to show variations in the number of rows of teeth in a radula and variations of the number of teeth in a row.

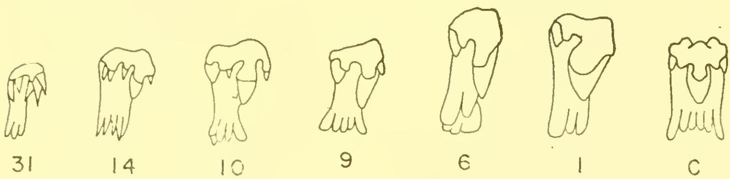


Figure 1. Representative teeth of a radula. 500x. C. Center; 1, lateral; 6, lateral; 9, lateral with an endocone; 10, marginal; 14, marginal; 31, marginal.

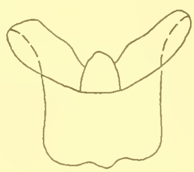


Figure 2. Jaw. 27x.

in a row is variable as well as the number of laterals and marginals. The number of the laterals and the marginals approaches a ratio of 1:3 or 1:4 as can be noted in Table II. The form of the teeth also is characteristic of the genus in that the basal plate is longer and more tapering than that of *Succinea* and *Catinella* (Quick, 1933, p. 296, figs. 1-4; Franzen, 1959, p. 195, fig. 3). In the laterals, an endocone is generally wanting but in some of the outermost laterals an endocone is present. A distinct endocone is generally, but not always present in the marginals. The ectocone

is single in the laterals and divided into 3 in the marginals excepting in the most medial ones in which it is divided into only two. In the outermost marginals, the lateral ectocone tends to be longer than the other two (Text Fig. 1). The variations of the tooth structure cannot be considered taxonomically signifi-

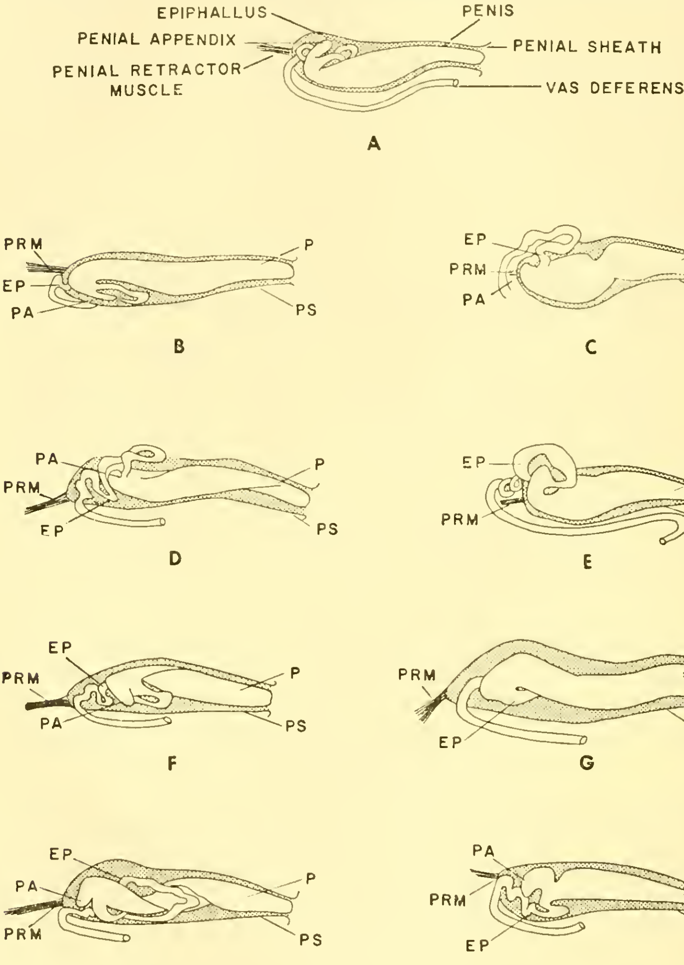


Figure 3. Penis shown inside of penis sheath cut open. All figures 13x. The figures are of snails taken from the following localities: A. Lake Okobojie; B. Waubun Prairie; C. Lake Okobojie; D. Lake Okobojie; E. Waubun Prairie; F. Waubun Prairie; G. Heron Lake; H. Lake Okobojie; I. Waubun Prairie.

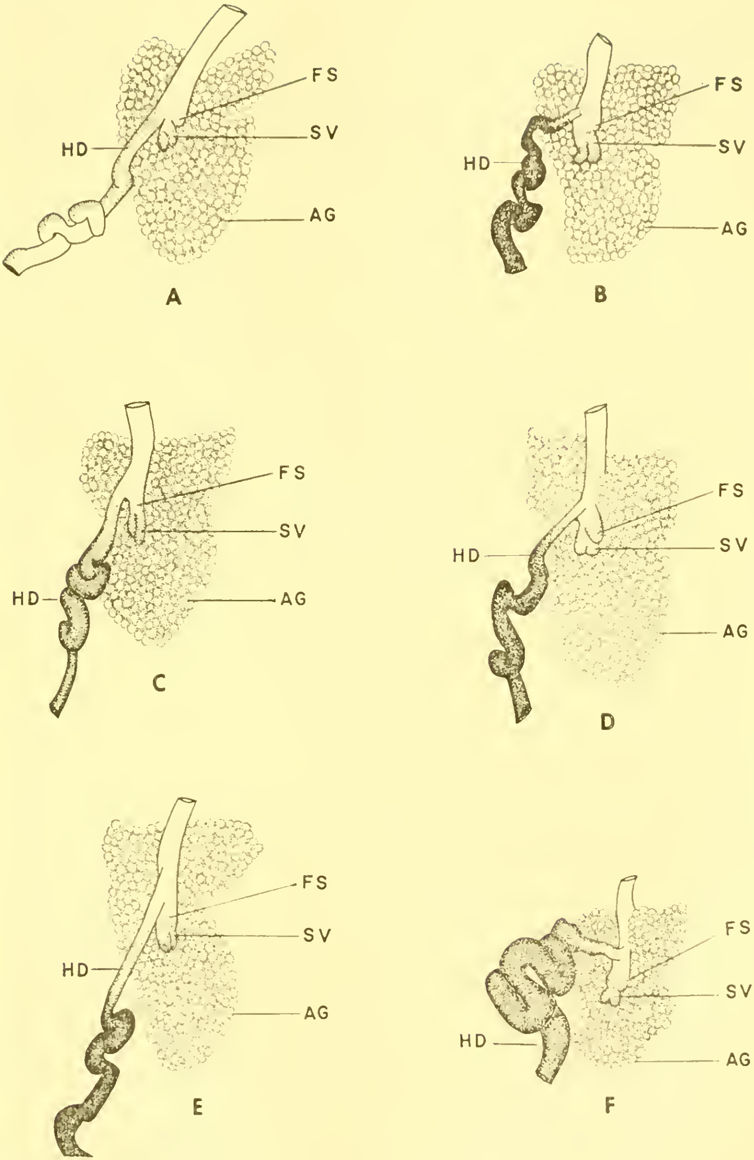


Figure 4. Albumin gland with fertilization sac and hermaphroditic duct. All figures 13x. The figures are of snails taken from the following localities: A. Lake Okobojie; B. Lake Okobojie; C. Waubun Prairie; D. Waubun Prairie; E. Lake Okobojie; F. Lake Okobojie.

cant because the same degree of difference is to be noted in other succineids.

The jaw of *O. retusa* is amber colored. It has a large median fold which projects anteriorly (text fig. 2). It lacks the small lateral folds which are characteristic of the jaw of *Succinea ovalis* Say (Franzen, 1959, p. 194, fig. 2). No significant structural variations have been noted.

Variations in the reproductive system. The penis and the vagina are located in the right anterior region of the animal. The penis is located to the left of the vagina. The vagina is nearly as long as the penis.

In *Oxyloma* the penis and epiphallus are enclosed in a penis sheath. In *O. retusa* the sheath is unpigmented excepting for a slight and variable amount of scattering of black flecks over its distal two-thirds. The epiphallus enters the penis sheath at its distal extremity and is coiled and recurved around the penis in no regular fashion before entering the penis. The sheath is too short to accommodate the penis and epiphallus without the penis being bent or recurved. Sometimes as much as the distal third of the penis is recurved anteriorly. The penis may be twisted a half turn (fig. 3, D, F) or a full turn (fig. 3, H).

In *Oxyloma* the epiphallus enters the penis subterminally. A penial appendix, usually directed ventrally, projects beyond this entry. In *O. retusa* the appendix may be directed dorsally (fig. 3, A). This is sometimes due to the penis being twisted a half turn (fig. 3, D). Generally the appendix is a distinct, slender, digitiform terminal structure (fig. 3, A). It may be a more inflated, straight or bent, structure even assuming the form of a hook (fig. 3, I). It varies in length from a pronounced to a reduced structure. In two individuals studied, one from Station No. 5 (fig. 3, E) and another from Station No. 6 (fig. 3, G) there was an absence of a recognizable appendix. The variations of the appendix were found not to be peculiar to any one population but were of general occurrence in the populations studied.

The seminal vesicle is a bilobed structure. The lobes vary in size. The two lobes may be equal in length (fig. 4, D, F), nearly equal (fig. 4, E) or one or the other markedly longer (fig. 4, A, C). The distal portion of the seminal vesicle is pigmented, the intensity of which is an individual variation. In a few indi-

viduals studied, the seminal vesicles were practically black. The fertilization sac varies in size from one which is scarcely differentiated from the seminal vesicle and the duct leading from the albumin gland to the prostate gland, to an inflated sac (fig. 4, D). The hermaphroditic duct is either inflated or quite slender. It may be lightly pigmented (fig. 4, A) or so heavily pigmented to be almost black. All these variations occurred among individuals of the same population and were found not to be restricted to any one station or geographic area included in this study.

Both, the prostate gland and the albumin gland, are follicular. The prostate gland is smaller than the albumin gland. No significant variation of either gland was observed.

SUMMARY

The size of the shell of *Oxyloma retusa* (Lea) is variable. The maximum height of the shell of a population was found to range from 8.3 to 19.8 mm. The ratios of height of aperture/height of shell, width of aperture/height of aperture, width of aperture/width of shell are too variable for any significantly characteristic ratios to be established.

The degree of pigmentation of the body and mantle varies from relatively light to essentially black. Anatomical variations in the genitalia include: 1. The penis may be bent or twisted a half or full turn. 2. The penial appendix may be a distinct, digitiform or more inflated structure. It may also be reduced to the extent that it is not discernible. 3. The lobes of the seminal vesicles may be equal in length, or one or the other may be longer. They may be lightly or very darkly pigmented. 4. The hermaphroditic duct may be slender or inflated, lightly or very darkly pigmented.

The number of rows of teeth and the number of teeth in a row is not constant. In the laterals an endocone is generally wanting but is sometimes present in the outermost laterals. An endocone is generaly present in the marginals. The ectocone of the marginals is divided into two or three ectocones. In the outermost marginals, the lateral ectocone tends to be longer than the other ectocones. No variations in the structure of the jaw were noted.

Because the populations with the smaller shells were sur-

rounded by populations exhibiting larger shells, this variation is considered as a local rather than a geographic variant. The anatomical variations discussed were found to occur in all the stations and were not restricted geographically. Comparative studies of the anatomical structures of the described species of the genus *Oxyloma* will have to be made before one can determine which bear significant specific characteristics and, therefore, can be employed in determining which species are valid.

Acknowledgments. This study was begun in the summer of 1956 while I attended the University of Minnesota Biological Station, Lake Itasca State Park, Minnesota. The expenses of that summer were partially covered by a grant from the Illinois State Academy of Science. During the summers of 1957 and 1958, this study was continued at that Station and supported by National Science Foundation for Training and Research for College Teachers stipends. A grant from Sigma Xi-RESA made possible the purchase of essential equipment for dissections. Currently my research studies are supported by a grant from the National Science Foundation. I am grateful to A. Byron Leonard for the reading of the manuscript and for making helpful suggestions.

Literature cited

Baker, H. B. 1935. In Manual of Conchology (Pilsbry). *28*: 191-209.

Boettger, Caesar R. 1939. Bemerkungen über die in Deutschland vorkommenden Bernsteinschnecken (Fam. Succineidae). Zool. Anz., *127* (3/4): 49-64, figs. 1-17.

Franzen, Dorothea S. 1959. Anatomy of *Succinea ovalis* Say. Proc. Mala. Soc. London. *33* (5, Nov.): 193-199, Tables I, II, figs. 1-7.

Lee, C. Bruce. 1951. *Succinea vaginacontorta* (Section Calcisuccinea), a new amber snail from Kansas. Occ. Papers Mus. Zoology, U. of Michigan, No. 533: 1-7, Pl. I, II.

Miles, Charles D. 1958. The Family Succineidae (Gastropoda: Pulmonata) in Kansas. Univ. Kansas Sci. Bull. *28*, Pt. II, No. 24, March 20: 1499-1543, Pl. 1, figs. 1-10.

Odhner, Nils Hj. 1950. Succineid studies. Proc. Mala. Soc. London. *28* (4 & 5): 200-210, figs. 1-6.

Pilsbry, Henry A. 1948. Land Mollusca of North America (North of Mexico). Acad. Nat. Sci. Philadelphia Mon. No. 3, Pt. 2: xlvii + 592, 585 figs.

Quick, H. E. 1933. The anatomy of British succineae. Proc. Mala. Soc. London, *20* (6 Nov.): 295-318, Pl. 23-25, figs. 1-18.

Steenberg, C. M. 1925. Etudes sur l'anatomie et la systematique

des maillots. Videnskapelige Meddelelsar fra Dansk Naturhistorisk Forening, Vol. 80.

Webb, Glenn R. 1953. Anatomical studies on some midwestern Succineidae and two new species. Jour. Tennessee Acad. Sci. *28*: 213-220, Pl. 1-5.

—— 1954. Pulmonata, Succineidae: *Succinea* (*Desmosuccinea*) *pseudavara,* new section and species. Gastropodia, *1* (2): 10, 18-19, figs. 4, 5, 13-17.

TWO MEXICAN SPECIES OF GUILLARMODIA S.S.

By FRED G. THOMPSON
Department of Zoology, University of Miami

The following account includes the descriptions of two species of *Euglandina* (*Guillarmodia* s.s., H.B. Baker, 1941) of the family Spiraxidae[1]. One species has been described inadequately and the other species is new.

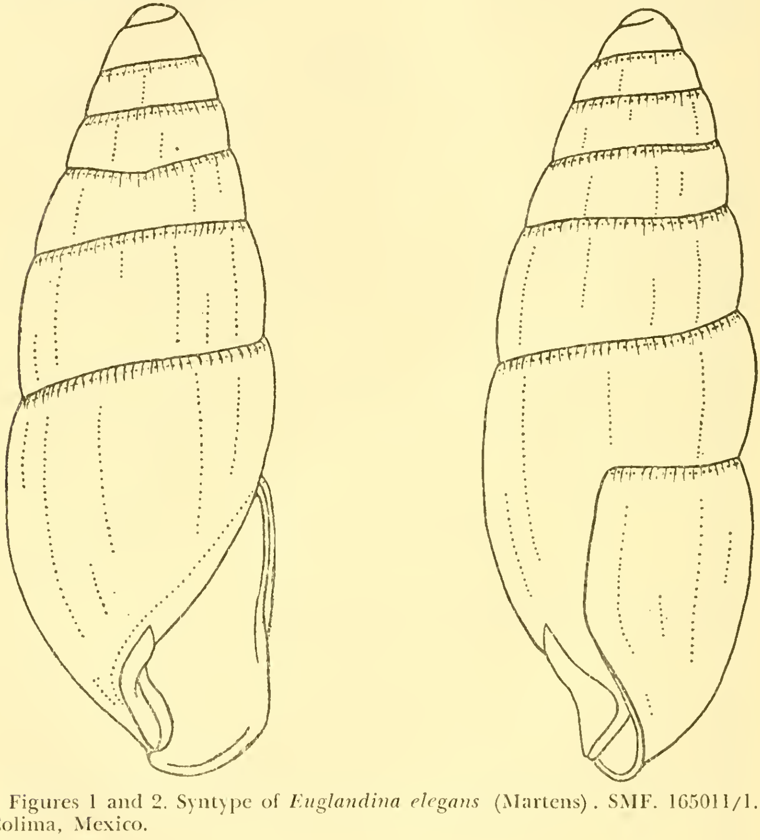
Martens, in Rolle (1895: 129), described *Salasiella elegans* from an unspecified locality in the State of Colima, Mexico, and illustrated two specimens in 1901. Pilsbry (1907:174) copied von Martens' description and illustrations without additional comment. The allocation of *elegans* to the genus *Salasiella* was primarily a matter of convenience as von Martens implied in his statement (1895: 129): "Mit keiner der bekannten Arten zu verwechseln". Baker (1941: 57) suggested a relationship between *S. elegans* and *Euglandina* (*Guillarmodia*) *pupa.*

Although von Martens' description and illustrations distinguished *elegans* from other spiraxids known at that time, they are inadequate for separating it from species discovered since then. The description is incomplete and inaccurate for it fails to describe properly the nature of the aperture and the columella, and the measurements given seem incorrect (". . . anfractus 8 . . . Alt. 11,5, Lat. 3,5, alt. apert. 4 mm.") . The illustrations are too vague for critical comparisons.

Von Martens did not designate a type specimen for *Salasiella elegans,* nor has any subsequent author. Two specimens in the Zoologischen Museum der Humboldt-Universitat zu Berlin are labeled "types", and two specimens in the Senckenbergische Naturforschungs Gesellschaft are labeled syntypes. If von Martens

[1] Oleacinidae, in part, of authors previous to Baker, 1956.

intended to give the measurements of the type, which he did not state, then none of these specimens is recognizable as the type. Since a type has not been designated by a previous author, I hereby select a specimen from the Berlin Museum as the lectotype, number 47661.



Figures 1 and 2. Syntype of *Euglandina elegans* (Martens). SMF. 165011/1. Colima, Mexico.

EUGLANDINA (GUILLARMODIA) ELEGANS (Martens) Figs. 1 & 2.

Salasiella elegans Martens in Rolle, 1895, Nach. Deut. Malak. Gesell.: 129. 1901, Biol. Cent. Amer.: 613; pl. 44; figs. 1, 1a. Pilsbry, 1907, Man. Conch., *19*: 174; pl. 28, figs. 58, 59.

Shell small, light yellow, elliptical-conical, hyaline; moderately thick, thinnest near attachment at suture, becoming increasingly thick to base of whorl; 7-7½ whorls: 2½ large, smooth embryonic whorls which are same color as rest of shell; remaining whorls slightly or moderately convex; middle of last whorl slightly im-

pressed near lip; suture slightly impressed on early whorls, moderately impressed on last two whorls, regularly descending to last two whorls, and then descending more rapidly; suture beveled, a pellucid light band formed by attachment of shell to preceding whorl; band marked by uniformly spaced slight crenulations; surface of shell glossy, with fine irregular growth striations; aperture irregularly lanceolate, 0.38 times the length of the shell; outer lip thick, blunt, arched forward in the middle, recessed below, continuous to the columella; columella at an angle to the axis of the shell in frontal view, sinuous, nearly truncate, bearing a thick, white, opaque, curved crest, which is about ½ the length of the aperture; parietal callus consisting of a thin, rugose, hyaline deposit.

Lectotype: height, 10.8 mm.; width, 4.0 mm.; aperture height, 4.3 mm.; aperture width, 1.9 mm.; crest, 1.8 mm.; 7½ whorls.

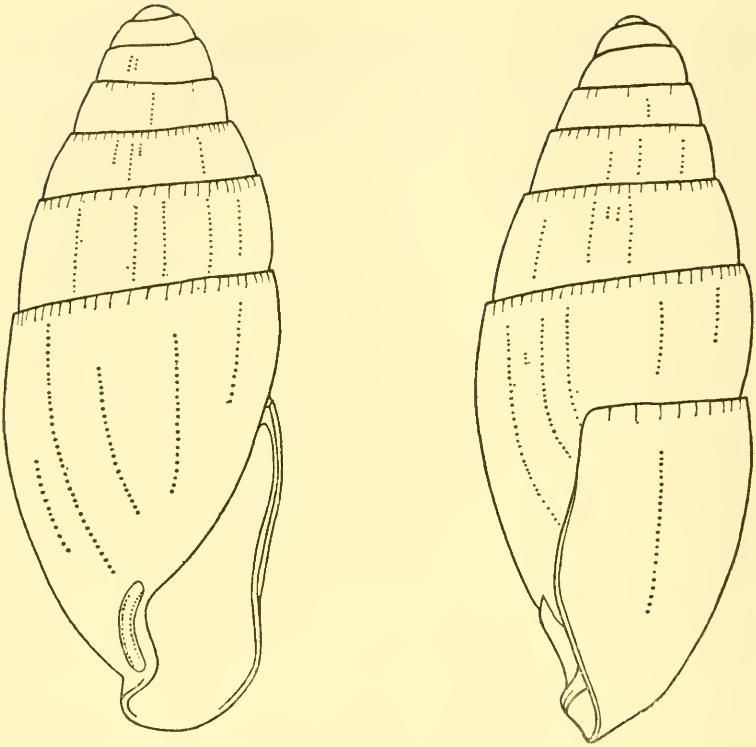
Syntypes: height, 9.7, 10.8 mm.; width, 3.7, 3.9 mm.; aperture height, 3.7, 4.1 mm.; aperture width, 1.7, 1.9 mm.; crest, 1.9 1.6 mm.

Lectotype: Berlin Museum 47661; collected in the state of Colima, Mexico by M. Rolle, without additional information about its original locality. Syntypes: SMF. 165010/1, SMF. 165011/1; same data as lectotype.

Measurements are not given for the other specimen in the Berlin Museum for it is badly deteriorated, and exact determinations cannot be made.

EUGLANDIA (GUILLARMODIA) DORSALIS new species. Figs. 3 & 4.

Shell small, elongate-ovate; subhyaline, the axis being faintly evident with the aid of strong transmitted light; shell thick, with greatest thickness at the periphery of the whorl, slightly thinner near suture with preceding whorl; 7¼ whorls; 2½ large, smooth, light colored embryonic whorls; remainder of shell light yellow; whorls slightly convex, the middle of the body whorl sometimes flattened; middle of last whorl impressed near lip; suture regularly descending on early whorls, more rapidly descending on last two or three whorls; at the suture the wall of the shell is truncate and lies juxtaposed to the preceding whorl so that a continuous spiral ledge extends along the suture from the embryonic whorls to the aperture, and is slightly concave throughout most of its length; surface of shell glossy, with weak and irregular crenulations at the suture; aperture elongate-auriculate, narrow, 0.45 times the length of the shell; lip arched forward in middle, moderately recessed below, continuous with columella; columella at an angle to axis of shell in frontal view, sinuous, bearing a stout, solid crest which overlies the curvature of the columella; parietal callus very thin, indicated by a fine, rugose, hyaline deposit.



Figures 3 and 4. Type of *Euglandina dorsalis,* new species. UMMZ. 213222. One mile north of Pomero, Michoacan, 700 feet alt.

Type: height, 11.97 mm.; width, 4.6 mm.; aperture height, 5.3 mm.; aperture width, 1.9 mm.; crest, 1.6 mm.

Paratype: height, 12.2 mm; width, 4.75 mm.; aperture height, 5.46 mm.; aperture width, 2.2 mm.; crest, 1.75 mm.

Type: UMMZ. 213222; one mile north of Pomero, Michoacan; 700 ft. alt. Collected in August, 1950 by James A. Peters. Paratype: ANSP. 277857; same data as the type.

Three species are currently recognized in *Guillarmodia* s.s.: *E. dorsalis* new species, *E. pupa* (Baker) and *E. elegans* (Martens). They may be distinguished as follows:

E. dorsalis: (1) columella oblique in frontal view, (2) columella with a strong callused crest, (3) suture slightly crenulate, (4) suture truncate, forming a continuous spiral ledge, (5) aperture 0.45 times length of shell, and (6) shell elongate-ovate, about 12 mm. long.

E. elegans: (1) columella oblique in frontal view, (2) columella

with a strong callused crest, (3) suture slightly crenulate, (4) suture beveled, forming a pellucid light band, (5) aperture 0.38 times length of shell, and (6) shell elliptical-conical, about 9.7-10.8 mm. long.

E. pupa: (1) columella vertical in frontal view, (2) columellar callus not forming prominent crest, (3) suture smooth, not crenulate, (4) suture beveled, forming a pellucid light band, (5) aperture about 0.44 times the length of shell, and (6) shell elongate-ovate, about 8 mm. long.

E. dorsalis and *E. elegans* are more closely related to each other than they are to *E. pupa,* because of their oblique, crested columella. *E. dorsalis* and *E. elegans* occur in geographically proximal regions of western Mexico, whereas *E. pupa* is known only from the state of Veracruz in eastern Mexico.

E. dorsalis derives its name from the ledge like nature of its suture.

I wish to express my gratitude to Dr. R. Kilias of the Zoologischen Museum der Humboldt-Universität, Berlin, for permitting me to examine the "types" of *Salasiella elegans* von Martens, and to Dr. Adolf Zilch of the Senckenbergische Naturforschungs Gesellschaft, Frankfurt, for lending me syntypes of the same species.

References

Baker, H. B. 1941, Naut., *55:* 51-61; pl. 5, figs. 1-15.

—— 1956, Naut., *69:* 128-139.

Martens, E. von. 1901, Mollusca. Biol. Cent. Amer.: 1-706; pls. 1-44.

Pilsbry, H. A. 1907-1908, Manual of Conchology, ser. 2, *19:* 1-366; pls. 1-52.

Rolle, M. 1895, *Nach. Deut. Malak. Gesell.:* 129-131.

CHECK LIST OF EAST CENTRAL ILLINOIS UNIONIDAE

By FREDRICK R. FECHTNER

The accompanying list represents the results of my investigation carried out in the 3 river systems: Embarrass, Little Wabash, and Kaskaskia and its tributaries in East Central Illinois from October of 1951 to October of 1953. The Embarrass and the Little Wabash Rivers flow east into the Wabash River and then into the Ohio River. The Kaskaskia and its tributaries flow west into the Mississippi River. An ecological study of this area is being developed and will soon be presented.

I wish to express my sincere appreciation to Dr. Fritz Haas,

DISTRIBUTION OF SPECIES BY RIVER SYSTEMS KEY: X - PRESENT

SPECIES	RIVER SYSTEMS							
	EMBARRASS	LITTLE WABASH	KASKASKIA	TRIBUTARIES OF KASKASKIA RIVER				
				OKAU R.	WOLF CR.	BECKS CR.	HURRI-CANE CR.	EAST FORK
Alasmidonta calceolus			X					
A. marginata			X					
Amblema gigantea	X	X	X				X	
A. plicata costata	X	X	X	X	X		X	X
A. plicata plicata			X					
Anodonta ferussaciana	X	X	X	X	X		X	
A. grandis	X	X	X	X	X	X	X	X
A. ohiensis	X							
Arcidens confragosa		X	X					
Carunculina parva	X		X					
Dysnomia triquetra			X					
Elliptio dilatatus		X	X					
E. tetrelasmus	X	X			X			
Fusconaia antrosa			X					
F. flava	X	X	X	X				X
F. kirtlandiana	X							
F. subrotunda	X							
F. undata	X		X					
Lampsilis cardium	X	X	X			X		
L. carinata	X	X	X					
L. fragilis	X	X	X					
L. siliquoidea	X	X	X	X	X	X	X	X
L. subrostrata	X							X
L. teres	X	X	X			X	X	X
Lasmigona complanata	X	X	X		X	X	X	X
L. costata	X		X	X				
Obliqueria reflexa	X		X					
Obovaria subrotunda	X		X					
Pleurobema cyphyum			X					
Proptera alata	X	X	X					
P. laevissima	X	X	X				X	
Quadrula coccinea	X	X						
Q. nodulata			X					
Q. pustulosa	X	X	X	X				
Q. quadrula	X	X	X				X	X
Q. tuberculata		X						
Strophitus undulatus	X		X	X				
Tritogonia verrucosa	X	X	X				X	
Truncilla donaciformis			X					
T. truncata			X					

Curator Emeritus of Mollusks at the Chicago Natural History Museum for his expert assistance in the identification of the various species. Representative specimens are catalogued at the Chicago Natural History Museum.

GASTROPODA OF THE 1961 UNIVERSITY OF COLORADO MUSEUM EXPEDITION IN MEXICO*

By BRANLEY A. BRANSON, Dept. Biol., Kansas State College, Pittsburg and CLARENCE J. McCOY, JR., University of Colorado Museum, Boulder

During June and July of 1961 an expedition, consisting of T. P. Maslin, L. A. Pennock, H. G. Rodeck and the junior author, from the Colorado University Museum, traveled in 21 Mexican states for the purpose of collecting cold-blooded vertebrates. A second trip to the Yucatan Peninsula was made in December by the junior author. Eleven families, 15 genera and 25 species of land and freshwater gastropods were secured, which form the basis for this report. Unless otherwise indicated the specimens are deposited in the University of Colorado Museum or that of Kansas State College. The writers are indebted to Dr. Hugo Rodeck, director of the University of Colorado Museum, for permission to report upon these specimens.

The following collecting stations are numbered consecutively so that the various species may be referred to the localities where they were secured.

Station 1. 8:VI:1961. In an ancient lake bed (Bolson de Mapimi), "La India," 7 miles east of Escalon, Chihuahua. Dominant vegetation mesquite.

Station 2. 10:VI:1961. Two miles southeast of Charro Blanco, San Luis Potosi. This station lies on the edge of a broad valley, typical high (6500 feet) Chihuahuan Desert, located in the Gulf rain shadow. The vegetation consists mainly of creosote bush, mesquite and a large species of yucca. The snails collected here were removed from the bases of tree yuccas.

Station 3. 6:VII:1961. Roadside pits, Villahermosa, Tabasco. The whole area is low and wet because of the influence of the nearby Rio Grijalva.

The following comments apply to the next five stations. The northern and western parts of the Yucatan Peninsula are nearly flat limestone plains with frequent bedrock outcrops in all direc-

* Supported in part by N. S. F. Grant G-16244

tions. The soil is shallow and forms small flats in depressions of the rocks. Near the coast the plain is about sea level and the outcrops progressively become more and more abundant toward the central part of the land mass, where they appear as a succession of wavy ridges. These ridges are five to six feet high with hollows of 10 to 100 yards between them. There is practically no surface drainage, consequently no surface streams. Instead, this whole section of the peninsula is underlain by water occasionally reaching the surface as open water holes varying in size from a few feet to over 200 yards in diameter, sometimes extending downward to great depths as massive caverns.

The northern part of the Peninsula is covered by a dense, low tropical forest near the coast, mostly scrubby brush 10 to 15 feet tall, which gradually increases in height leeward; at Piste a stunted forest, 25 to 40 feet tall, with dense undergrowth, is produced. The trees are mostly leafless in the dry season. (Goldman, 1951).

Station 4. 16:VI:1961. 5 to 11 miles east of Campeche, Campeche.

Station 5. 16:VI:1961. 32 miles east of Campeche. A shallow-soiled, limestone area with a thorn forest.

Station 6. 16:VI:1961. 30 miles south of Uxmal, Yucatan, in Campeche.

Station 7. 16:XII:1961. Airport, Ciudad del Carmen, Campeche.

Station 7A. 16:VI:1961. 16 miles east of Campeche, Campeche.

Station 8. 19:VI:1961. 1½ miles south of Libre Union, Yucatan. A thick forest near a water hole. Specimens removed from bases of larger trees.

Station 9. 18:VI:1961. Piste, Yucatan, Deciduous thorn forest.

Station 10. 26:VI:1961. 3.3 miles north of Valladolid, Yucatan.

Station 11. 18, 18:VI:1961. 19 miles east of Merida, Yucatan. A deciduous thorn forest.

Station 12. 3:VII:1961 and 20:XII:1961. 3 kilometers south of San Miguel, Isla de Cozumel, about 10 miles off Quintana Roo coast. Palmetto and thorn trees, very dense.

Station 13. 18:VII:1961. 8 miles southwest of Colima, Colima. A scrubby, overgrown area.

Annotated list of species

Lucidella lirata (Pfeiffer). Station 7; 1 immature and 2 mature shells. Heretofore this species has been known from Veracruz, Chiapas, Tabasco, Yucatan and Quintana Roo. It doubtless is

widespread in southern Mexico and adjacent Central America. These specimens were found under dead *Ficus* leaves.

Neocyclotus dysoni aureus (Bartsch and Morrison). Station 4; 8 freshly dead shells. Although the coloration and size of these shells is similar to that of *N. dysoni aureus* the relatively closely-spaced, somewhat vermiculated sculpture and almost completely adnate aperture (Harry, 1950) indicates some intergradation with *N. dysoni ambiguum* (v. Martens), the northernmost race of the species (Solem, 1956; Thompson, 1957). *N. d. aureus* supposedly ranges from Oaxaca southward (Bequaert, 1957). However, the shells we observed indicate that Campeche and adjacent regions may be areas of intergradation.

Neocyclotus berendti (Pfeiffer). Station 8; 3 living and 3 dead shells. As pointed out by Solem (1956), Bequaert and Clench (1933) considered this to be a distinct species rather than a race of *N. dysoni*. Solem also stated that specimens with characteristics intermediate between *berendti* and *ambiguum* can be found in Veracruz. We are of the opinion that the Veracruz specimens are more apt to be intergrades between *aureus* and *ambiguum* and further agree with Bequaert and Clench that *N. berendti* should be considered as a full species. The sculpture is always coarse and only slightly, if at all, vermiculated. The lip is nearly, to completely, free from the adjacent body whorl, especially in large specimens, and the size is larger than that in the races of *N. dysoni* which approach *N. berendti* in sculpture. The soft anatomy of whole genus badly needs investigation. The operculum of this species was illustrated by Drake (1957).

Pomacea flagellata (Say). Station 3 and 4; 4 living specimens. This is an exceedingly variable species which ranges from Veracruz southward. About 30 specific and subspecific epithets have been applied to many of these "races", supposedly separable by size differences (Bequaert, 1957), many of which can be found living at the same place. The shell size appears to vary with the size of the body of water in which the animals dwell (Goodrich and van der Schalie, 1937), large ones coming from large pools, etc. Furthermore, shell size is apparently modifiable by man's activities. Baker (1922) found that specimens of *A. flagellata* taken from burned-over areas never attain the size of ones from unchanged regions. Bequaert and Clench (1936) were apparently

also of the opinion that the subspecies are untenable since they recorded the species only as *P. flagellata* from two localities in Campeche.

Most species of *Pomacea* are nocturnal and living animals are seldom collected in daylight. Thompson (1957) found living snails during the night in Tabasco and the junior author observed numerous ones ovipositing on emergent vegetation after sunset.

Choanopoma gaigei Bequaert and Clench. Stations 4, 8 and 11; 43 specimens. This species was first described from Chichen Itza, Yucatan (Bequaert and Clench, 1931) and has not been widely discussed since, although periodically reported from various localities. The Campeche sites represent new localities for the species in Mexico and those in Yucatan, different ones for that state.

In all of our specimens the duplex aperture is brick red and the nucleus of the operculum, in which the calcareous part does not completely cover the horny portion, is strongly eccentric. The tendency to retain all of the apical whorls in the adult stage, remarked upon by Bequaert and Clench (1931) was not noted by us. Only one shell possessed a bored hole, supposedly made by the larva of a beetle in order to stimulate the snail to protract so that it could be eaten (Harry, 1950). The latter worker found 10 to 25 per cent of the shells, in all species of *Choanopoma,* to be thus bored.

Choanopoma largillierti (Pfeiffer). Stations 4, 5, 8 and 11; 14 dead and 5 lives shells. Because of its apparent larger size and finer sculpture Baker (1928) separated *C. grateloupi* Pfeiffer as a distinct species. However, Bequaert and Clench (1936), followed by Harry (1950), agreed with von Martens (1890-1901), after observing a series of several hundred shells, that it was difficult if not impossible to recognize the two species. The shells herein listed from stations 4, 5 and 8 are all fairly small and bear strongly cross-hatched sculpture; the nodules at the sutures are very well-developed. The latter shells are very definitely of the *C. grateloupi* type. The other 10 specimens, one of which bears a bored hole, average somewhat larger, have only moderate cross-hatching, and the nodules are weakly developed. All the specimens have the apical whorls decollate. This genus also needs to

be thoroughly investigated.

Pachycheilus tristis Pilsbry and Hinkley. Two specimens of this beautiful species were collected by Mr. Tom Linton, University of Oklahoma, on 27:V:1961, from the Salto River, just above the falls, in San Luis Potosi. The carination is somewhat reduced.

Streptostyla meridana (Morelet). Stations 4, 6 and 11; 5 dead shells, Baker (1941), Harry (1950) and Bequaert and Clench (1933, 1936, 1938) recorded this form from several Yucatan localities but the Campeche sites are apparently new.

Streptostyla ventricosula (Morelet). Station 5; a single dead shell (29.0 × 11.5 mm; 7 whorls). This is another widespread species (Goodrich and van der Schalie, 1937) reported from about the same localities as the last form.

Streptostyla maslini Branson and McCoy. Stations 7 and 11; (dead shells). This species is most closely related to *S. yucatanensis* Pilsbry.

Streptostyla toltecorum Branson and McCoy. Station 4; 2 adult and 2 immature shells. This species is most closely related to *S. meridana* (Morelet).

Euglandina cylindracea (Phillips). Station 7; 2 living and 17 dead shells. The plicate sculpture, starting immediately after the embryonic whorls, mentioned by Goodrich and van der Schalie (1937) in specimens from Guatemala, is obvious in all of our shells. Baker (1941), Harry (1950) and Bequaert and Clench (1933, 1936, 1938) listed the species from several Yucatan localities but not from Campeche. The fresh peristome is pinkish-buff and the interior of the aperture is a beautiful glossy pink.

Bulimulus unicolor (Sowerby). Station 13; 3 dead shells. This is a common species in southern Mexico and Central America (Bequaert, 1957) but not, we believe, heretofore reported from Colima.

Bulimulus ignavus (Reeve). Station 7; a single dead (immature) shell. This specimen agrees closely with the findings of Harry (1950) in shells from Yucatan. It has nearly a full whorl more than a shell of comparable size in *B. unicolor.*

Bulimulus schiedeanus (Pfeiffer). Station 1; 8 dead shells.

Bulimulus alternatus Binney. Station 2; 15 dead shells.

Both of the last two species are common in the areas herein reported.

Drymaeus serperastrus (Say). Stations 8, 9 and 12; 1 living and 7 dead shells. All but one (nearly white) of the shells of this somewhat variable species were banded. Harry (1950) also noted the lack of banding in one shell from Yucatan and Solem (1955) and Bequaert and Clench (1933, 1938, 1936) listed some Yucatan sites.

Drymaeus sulphureus (Pfeiffer). Stations 7, 7a and 8; 1 immature and 2 adult shells. The characteristic cross-barred sculpture (Solem, 1950) is definite in all three shells and the apex is slightly pink; the rest of the shell is nearly white, only a very faint yellowish coloration being discernable.

Drymaeus shattucki Bequaert and Clench. Station 12; 3 freshly dead shells. This is a beautiful glossy, waxen-white species with pink apical whorls, umbilicus and columella. There is no sign of banding and the body whorl is slightly carinated. The type locality is at Chichen Itza, Yucatan (Bequaert and Clench, 1931) and Bequaert and Clench (1933, 1936, 1938) recorded it from some other Yucatan localities. Goodrich and van der Schalie (1937) found the species in nine disturbed areas in Guatemala. This is the form described as *O. shattucki cozumelensis* by Richards (1937) and may be a distinct species.

Drymaeus tropicalis (Morelet). Stations 4 and 5; 1 adult and 1 immature shell. This species, a relative of *D. shattucki* (Bequaert and Clench, 1931), is easily recognized by being sinistral but otherwise very similar to the last-named form. Our specimens have four very narrow revolving bands on the body whorl.

Orthalicus princeps (Broderip). Stations 5, 8, 10, 12 and 13; 4 living and 9 dead shells. There is considerable variation as concerns the number of whorls, at any given size, from one locality to the next. There is also a great deal of variation in color pattern. The specimens from Colima have dark purple apical whorls, a dark purplish-brown peristome and columella, and a rather sparsely-streaked exterior. The interspaces between the streaks are about one-third wider than the streaks themselves. In the smaller specimens from Cozumel the peristome and columella are whitish (light purple in the larger ones) and the apex is white in all them. The shell is profusely marked by jagged brown bands that become progressively more crowded until behind the aperture they nearly fuse to produce an olivaceous-

brown coloration. Below the periphery the bands are intensified and partially retain their identity. The specimen from Campeche is a badly bleached dead one. However, in the Yucatan specimens the color pattern is somewhat similar to that seen in Quintana Roo but the interspaces nearly equal the bands in width.

This is a widespread form from Veracruz and Sinaloa to Panama (Bequaert, 1957) but little is known concerning its biology. Harry (1950) suggested that the species was arboreal and Baker (1923) found it only on trees. McCoy collected several on Cozumel 10 to 15 feet above the ground in fig trees, one of which had the eggs of an arboreal lizard attached to the shell. Dead shells are abundant in this area, many of which are broken because a species of terrestrial hermit crab utilizes them as temporary shelters, thus fracturing the relatively fragile shells as they are dragged over the rocky soil.

Microceramus consisus (Morelet). Station 4; 2 dead shells. This is a common species in Yucatan (Bequaert and Clench, 1933) and extends southward at least to Guatemala (Goodrich and van der Schalie, 1937) and several island states (Bequaert, 1957). As pointed out by Harry (1950), the shell sculpture is coarser and the diameter greater in Guatamala specimens than in those from Yucatan. Comparing the measurements of the Campeche specimens with those listed by Bartsch (1906) for one from Guatamala it would appear that the former are somewhat intermediate between the Yucatan and Guatamala forms. These characters probably vary clinally.

Subulina octona Bruguière. Stations 3 and 7; 9 living and 33 dead shells. This is an exceedingly widespread species in southern North and Central America (Pilsbry, 1946). It has been recorded from Tabasco by Thompson (1957) and others and from Campeche by Richards (1937). The specimens herein reported from Tabasco were taken from the stomachs of *Bufo marinus* which feeds upon them in great numbers. Several of the individuals, apparently preserved soon after being swallowed, still contain the animal and single eggs in the penultimate whorl.

Praticolella griseola (Pfeiffer). Station 4; 2 living and 9 dead shells. Bequaert and Clench (1936) and Harry (1950) consider this to be an imported species since they found it commonly in areas altered by the activities of man. However, *Praticolella,* in

general, prefers open habitat to forested regions. Goodrich and van der Schalie (1937) found it most common in open areas of Guatemala. Man may augment the distribution of this form by his clearing activities, rather than actually transporting it to new localities.

Pupisoma dioscoricola (C. B. Adams). Station 7; a single fresh dead specimen. This is an exceedingly widespread form which is only seldom collected because of its minute size and secretive arboreal habits.

Literature cited

Baker, H. B. 1922. Occ. Pap. Mus. Zool. Univ. Mich. 106:1-95.
—— 1923. Occ. Pap. Mus. Zool. Univ. Mich. 135:1-19.
—— 1925. Occ. Pap. Mus. Zool. Univ. Mich. 156:1-57.
—— 1928. Occ. Pap. Mus. Zool. Univ. Mich. 193:1-65.
—— 1930. Occ. Pap. Mus. Zool. Univ. Mich. 220:1-45.
—— 1941. Naut. *55*:51-61.
—— 1945. Naut. *58*:84-92.
Bartsch, P. 1906. Proc. U. S. Nat. Mus. *31*:109-160.
Bequaert, J. C. and W. J. Clench. 1931. Occ. Pap. Boston Soc. Nat. Hist. 5:423-426.
—— 1933. Pub. Carnegie Inst. Wash. 431:525-545.
—— 1936. Pub. Carnegie Inst. Wash. 457:61-75.
—— 1938. Pub. Carnegie Inst. Wash. 491:257-260.
Drake, R. J. 1957. Bull. So. Calif. Acad. Sci. 56: 113-118.
Goldman, E. A. 1951. Smiths. Misc. Publ. *115*:1-476.
Goodrich, C. and H. van der Schalie. 1937. Univ. Mich. Mus. Zool. Misc. Publ. 34:1-50.
Harry, H. W. 1950. Occ. Pap. Mus. Zool. Univ. Mich. 524:1-34.
Martens, E. von. 1890-1901. Biol. Cent. Amer., *9*:i-xxviii, 1-706.
Pilsbry, H. A. 1903. Proc. Acad. Nat. Sci. Philad. 1903:761-789.
—— 1946. Mongr. Acad. Nat. Sci. Philad. III;2 (1) :i-viii;1-520.
Richards, H. G. 1937. Proc. Amer. Micros. Soc. *77*:249-262.
Solem, A. 1955. Occ. Pap. Mus. Zool. Univ. Mich. 566:1-20.
—— 1956. Proc. Acad. Nat. Sci. Philad. *108*:41-59.
Thompson, F. G. 1957. Naut. *70*:97-102.

CARYCHIUM EXILE AND CARYCHIUM EXIGUUM

By Leslie Hubricht

Harry (1952), and more recently, Branson (1961) have expressed the belief that *Carychium exile* H. C. Lea was only an ecological form of *Carychium exiguum* (Say). However, I have found them living together at many places and they could always

be readily sorted. There is no real problem separating these two species when the differences are fully understood. *C. exiguum* is usually smoother than *C. exile,* but there is some intergradation in this character. *C. exiguum* is more obese and usually larger than *C. exile.* But the best distinguishing character is found in the outer lip. In *C. exiguum* the outer lip is somewhat expanded, but in *C. exile* it is narrowly reflected. This appears to be a constant difference which will stand up when other characters fail.

Carychium exiguum is a more northern species. Although it ranges southward along the Atlantic Coast as far as the Savannah River, in the interior it does not range as far south. In Kentucky it has not been found south of the flood-plain of the Ohio River. Westward its southern limit is central Missouri, and Kansas. All records from south of this line appear to be based on missidentifications. The records from Alabama are based on *Carychium floridanum* Clapp. *C. exiguum* also occurs in the Rocky Mountain region in Colorado and New Mexico.

Carychium exile ranges south to western South Carolina, northern Georgia, Alabama, Mississippi and westward into Oklahoma. It is occasionally found on the Gulf Coastal Plain in hilly terrain.

Carychium floridanum has a much wider range than has been generally believed. It ranges northward along the Atlantic Coast at least as far as the Santee River in South Carolina. It ranges across the Gulf Coastal Plain into Texas. The author has collected it in Dallas and Comal Counties in Texas.

References

Branson, Branley A. 1961. Proc. Okla. Acad. Sci. *41:* 45-69.

Harry, Harold W. 1952. Nautilus *66:* 5-7.

Walker, Bryant 1928. The Terrestrial Shell-Bearing Mollusca of Alabama. Univ. Mich. Mus. Zool. Misc. Publ. No. 18. pp. 172-173.

NOTES AND NEWS

New mollusk research journal.—A new international malacological journal is being established and will begin publication in October with the help of a grant from the U.S. National Science Foundation. Malacologia will contain reports of original research in all aspects of the study of mollusks: their

morphology, ecology, life histories, evolution and fossil record, classification, zoögeography, physiology, biochemistry, cytology, histology and embryology. Monographs and longer papers which cannot be printed in existing malacological journals will be accepted. The new journal will have an international editorial board of well known malacologists and will publish in 5 languages: English, French, German, Russian, and Spanish. Editorial offices will be at the Museum of Zoölogy, University of Michigan, Ann Arbor. In the beginning, publication will be irregular. Volumes will be as nearly equal in size as practicable. Authors will receive 25 reprints of their papers. Subscription price is $5.00 per volume (450 pages).

Additional information about MALACOLOGIA may be obtained from J. B. BURCH, Executive Secretary-Treasurer, Institute of Malacology, 2415 South Circle Drive, Ann Arbor, Michigan.

ANTHRACOPUPA AND MATURIPUPA.—The inclusion of these 2 Paleozoic groups in the Cyclophoridae by J. Brookes Knight, et al., 1960, Invertebrate Paleontology *1* (1): 318, seems highly improbable. Perhaps the most constant, shell character in the family is that on which its name is based: The rounded apertures, which permit its members to have multispiral opercles. In neither of these genera is the opening even subcircular, and the prominence of the parietal tooth probably would discourage the retention of any operculum. Pilsbry's intuition, 1926, Man. Conch. (2) *27:* 316, that they might be Auriculidae or Tornatellinidae, appears much more rational.—H. BURRINGTON BAKER.

PAGES.—The extra 4 pages of this issue are possible because of a contribution generously offered by Dr. Dorothea Franzen, and her paper exceeds our outside limits of 10 pages in any one number.—EDITORS.

OTALA LACTEA AT VICKSBURG, MISS.—The author recently found *O. lactea* (Müller) in a grassy lot near the depot at the foot of Jackson Street, Vicksburg, Warren Co., Mississippi. In many of the specimens, the bands are solid as in *Otala vermiculata* (Müller), not speckled with white as in specimens from Cockspur Island and Savannah Beach, Georgia.—LESLIE HUBRICHT.

Resistance to desiccation in dormancy *by Tectarius muricatus*[1]—In July, 1960, John E. Ott, Department of Geology, U. S. National Museum, collected *Tectarius muricatus* (Linnaeus, 1758) at Boca Raton, Florida. Specimens were carried to his home in Maryland and placed in a box where they remained until January, 1962. At that time Mr. Ott's son noticed that one of the sanils was attached to the side of the box. When removed the animal was seen to withdraw within the shell. The specimen was brought to the Division of Mollusks where it emerged and moved about when wet with sea water. It lived for several weeks in a damp chamber making periodic excursions, but usually remained attached by a strand of hardened mucus high on the wall of the container far from the water.

A review of the literature indicates that this phenomenon is not too unusual except for survival under completely dry conditions. In nature *T. muricatus* lives on the highest rocks of the shore where it is dampened only occasionally by salty spray. This species lived for more than two years in the laboratory with only periodic wetting (F. A. Hassler, 1873, Proc. Acad. Nat. Sci., Phila., p. 284). Under similar conditions *T. muricatus* survived for 17 months, *Nodilittorina tuberculata* (?) for 12 months, and *Littorina ziczac* for 7 months (Mattox, N. T., 1949, Ecology, vol. 30, pp. 242-244). *Littorina pintado* in Hawaii lived for nearly a year attached to a laboratory wall (Emundson, C. H., 1946, Reef and Shore Fauna of Hawaii, p. 155).

There are several possibly valid records of very prolonged periods of dormancy in land pulmonates (23 years, Nautilus, *48:* 5-6; 15 years, Phil. Trans. Roy. Soc. London, 1774, *64:* 432-437). Some desert pulmonates are known to remain dormant as long as 6 years (Pelseneer, 1935, Essai d'éthologie, p. 137). For a marine prosobranch gastropod, however, survival during an 18 month period of dry dormancy is quite unusual. The ability to exist under such conditions demonstrates the adaptability of mollusks and is one reason why the phylum has been so successful through geologic time.—Joseph Rosewater, Division of Mollusks, U. S. National Museum.

Further comment on the debated species, *Strombus canaliculatus* Burry.—In my collection are two aberrant examples

[1] Published by permission of the Secretary of the Smithsonian Institution.

of *Strombus gigas* L., one of which has suffered damage with consequent malformation at the 7th whorl, the other (a near-adult) at the 9th. In both cases repair was begun well back inside the aperture and the new whorls are separated from the earlier ones by a deep canal and decided modification of the tubercules. Quite likely, if either of these specimens had been injured in infancy, it would have developed to resemble that described by Mr. Burry. No locality data accompany these shells, which came from the collection of Imogene Robertson. She employed them, together with aberrants of other species, to illustrate the recuperative ability of injured mollusks.—MARGARET C. TESKEY.

LYOGYRUS GRANUM (Say) in Mississippi—This species has been found at two places in the headwaters of the Pearl River. The first place was a small stream near Nanih Waiya Mound, south of Claytown, Winston County, where a single specimen was collected. Later it was found abundant in a stream below Nanih Waiya Caves, in the northeastern corner of Neshoba County. Although considerable collecting has been done in the southern part of the State it has not been found elsewhere.—LESLIE HUBRICHT.

TYPE MATERIAL OF THE SLUG PALLIFERA PILSBRYI—Recently, Miles and Mead (Nautilus, *74* (2), 1960) described a new *Pallifera* from southern Arizona [cf. also Amer. Malac. Union, Ann. Rept., 1960:25]. *Pallifera pilsbryi pilsbryi* has been collected in two localities in the upper elevations of the Santa Catalina Mountains, while *P. p. santaritana* is known only from the type locality in the Santa Rita Mountains. Seven topotypes of the nominate subspecies have been collected since our first report. The purpose of this notice is to designate the location and museum numbers of all type material now extant for this species of slug. Museum numbers are those assigned by the respective institutions.

Pallifera pilsbryi pilsbryi. California Academy of Science Paleo. Type Collection: Holotype (dissected), number 12,278, and one paratype, collected 25 July, 1960; 3 topotypes collected 13 November, 1960. Academy of Natural Science of Philadelphia: One paratype, collected 23 October, 1955; three topotypes collected 13 November, 1960. Museum of Invertebrate Zoology, University of Arizona: One [not two, as originally reported] paratype, collected 25 July, 1960; one topotype collected 13

November, 1960.

Pallifera pilsbryi santaritana. California Academy of Science Paleo. Type Collection: Holotype (dissected), number 12,280, collected 2 August, 1960, and one paratype, collected 13 July, 1960. Museum of Invertebrate Zoology, University of Arizona: One dissected paratype, collected 13 July, 1960.—Charles D. Miles and Albert R. Mead, University of Arizona, Tucson.

PUBLICATIONS RECEIVED, 1960

Pages in *italics* include new taxons

Azuma, Masao. Studies on the raulae of Japanese Cypraeacea (1). Hyogo Biology *4:* 50-55, figs. 1-27. A catalogue of the shell-bearing Mollusca of Okinoshima, Kashiwajima and the adjacent area (Tosa Province), Shikoku, Japan. *102* + 17 pp., 5 pls. & map.

Hubendick, Bengt. Faunistic review of the Ancylidae of Lake Ochrid. Srpsko Biol. Drust. Archiv Biol. Nauka *12:* 89-97, pls. 1-4.

1961

Barbosa F. S., B. Hubendick, E. T. A. Malek & C. A. Wright. The generic names *Australobris, Biomphalaria, Platytaphius, Taphius* and *Tropicorbis* (Mollusca, Planorbidae). Ann. Mag. Nat. Hist., ser. 13, *4:* 371-375.

Basch, Paul F., Philip Bainer & Harry Wilhm. Some ecological characteristics of the molluscan fauna of a typical grassland situation in east central Kansas. Amer. Mid. Nat. *66:* 178-199.

Getz, Lowell L. An attempt to infect mollusks with *Acanthamoeba* sp. J. Parasitology *47:* 842.

Jaeckel, Siegfried H. Mollusca-Weichtiere. Exkursionsfauna v. Deutschland *1:* 102-229, figs. 103-227.

Ladd, Harry S. Distribution of molluscan faunas in the Pacific islands during the Cenozoic. Geol. Surv. Prof. Paper 400-B: 372-375, map.

Paraense, W. Lobato. Shell versus anatomy in planorbid systematics. I: "*Australorbis glabratus.*" Rev. Brasil. Biol. *21:* 163-170, 7 figs.

Riedel, A. Ueber *Hyalina (Retinella) oscari* Kimakowicz, 1883, die typische Art der Untergattung *Schistophallus* A. J. Wagner, 1914 (Gastropoda, Zonitidae). Bul. Acad. Polon. Sci., cl. 2, *9:*133-137, figs. 1-3.

Schalie, Henry van der. The naiad (freshwater mussel) fauna of the Great Lakes. Great Lakes Res. Div., Inst. Sci. & Tech., Univ. Mich. Publ. 7: 156-157.

Taft, Celeste. The shell-bearing land snails of Ohio. Ohio Biol. Surv. Bul. *1* (3): xii + 108 pp., many figs.

Warmke, Germain L. Brown paper nautilus recovered from fish stomach in Puerto Rico. Carbb. J. Sci. *1*: 142.

1962

Aguayo, Carlos G. Notas sobre moluscos terrestres antillanos—II. Caribb. J. Sci. *2*:9-12.

Baker, H. Burrington. Type land snails in the Academy of Natural Sciences of Philadelphia. I. North America, north of Mexico. Proc. Acad. Nat. Sci. *114*: 1-21.

Burch, John B. How to know the eastern land snails. W. C. Brown Co., 135 South Locust St., Dubuque, Iowa. Pictured Key Nature Series: 214 pp., 519 figs. $2.50.

Clarke, Arthur H., Jr. Annotated list and bibliography of the abyssal marine molluscs of the world. Nat. Mus. Canad, Bul. no. 181: 114 pp., 2 maps.

Coomans, H. E. The marine mollusk fauna of the Virginian area as a basis for defining zoogeographical provinces. Beaufortia, Zoo. Mus. Amsterdam *9*: 83-104, 2 maps.

Gibson, Thomas G. Revision of the Turridae of the Miocene St. Mary's Formation of Maryland. J. Paleont. *36*: 225-246, figs. 1-7, pls. 39-42.

Haas, Fritz. A new species of land snail from Bolivia. Fieldiana-Zoo. *44: 67-68,* fig. 19.

Heard, William H. The Sphaeriidae (Mollusca: Pelecypoda) of the North American Great Lakes. Amer. Midl. Nat. *67*: 194-198.

Herrington, H. B. A revision of the Sphaeriidae of North America (Mollusca: Pelecypoda). Misc. Publ. Mus. Zool. Univ. Mich. no. 118:74 pp., 2 figs. 7 pls.

Hubendick, Bengt. Studies on *Acroloxus.* (Moll. Basomm.). Medd. Götebergs Mus. Zoo. Avdel. 133: 68 pp., 35 figs.

Kondo, Yoshio. The genus *Tubuaia.* Pulmonata, Achatinellidae. Bul. Bishop Mus. no. 224:*49 pp.,* 14 figs.

Parodiz, Juan José. New and little-known species of South and Central American land snails (Bulimulidae). Proc. U. S. Nat. Muse. *113: 429-456,* pls. 1 & 2.

Riedel, Adolf. Materialien zur Kenntnis der palæarktischen Zonitidae (Gastropoda) VII-VIII. Ann. Zoo. Polska Akad. Nauk. *20: 221-227,* figs. 1-11

Robertson, Robert. Supplementary notes on the Rissoellidae (Gastropoda). Notul. Nat. Acad. Nat. Sci. Philadelphia no. 352: 2 pp.

Schalie, Henry van der, Lowell L. Getz & Bonifacio C. Dazo. Hybrids between American *Pomatiopsis* and Oriental *Oncomelania* snails. Amer. J. Trop. Med. & Hyg. *11:* 418-420, figs. 1 & 2.

Yamamato, Gotaro & Tadashige Habe. Fauna of the shell-bearing mollusks in Mutsu Bay. Scaphopoda & Gastropoda (1). Bul. Mar. Biol. Sta. Asamushi *11:* 1-19, pls. 1-3.

THE NAUTILUS

Vol. 76 April, 1963 No. 4

RECORDS OF MARINE MOLLUSKS EATEN BY BONEFISH IN PUERTO RICAN WATERS[1]

By GERMAINE L. WARMKE and DONALD S. ERDMAN[2]

Mollusks are an important food item in the diet of many species of bottom-feeding fish. Clapp (1912) listed 68 species of mollusks from haddock. Baker (1916) found 46 of 54 fish species from Oneida Lake to be mollusk feeders; moreover, he recovered some 40 different species of mollusks from the digestive tracts of these fish. Hiatt and Strasburg (1960) found mollusks in the stomachs of 53 out of 233 reef fishes in the Marshall Islands. Randall (MS) has found mollusks to be a major component in the food of 51 out of 180 species of reef and inshore fishes of Puerto Rico and the Virgin Islands. He reports the most important mollusk-feeding groups as: stingrays, eaglerays, wrasses, porgies, grunts, mojarras, puffers, porcupine fishes, and bonefish. Erdman (1960) found that 56 percent of all food consumed by a large group of bonefish was mollusk in origin. Other authors have reported on the mollusk-feeding habits of fishes but relatively few have identified the mollusks to species.

It was the purpose of the present study to identify the mollusks eaten by the bonefish (*Albula vulpes* Linnaeus) in Puerto Rico and to determine if this species eats all mollusks indiscriminately, or if it shows preference for certain ones.

Fifty-six bonefish, weighing between 3/4 and 10 1/4 lbs., were examined individually during this study. The majority of the fish were caught by means of gill and trammel nets and seines, usually set on moonless nights. All fish were collected in the reef areas of La Parguera, on the southwest coast of Puerto Rico; or at Culebra, an island off the east coast of Puerto Rico. The whole digestive tract was removed, and the contents of both stomach and intestine were carefully examined. The different classes of

[1] Part of this work has been made possible through Federal Aid projects F-1-R Dingell-Johnson Act, for game fish research.

[2] Curator of Mollusks, Institute of Marine Biology, University of Puerto Rico; and Biologist, Division of Fisheries and Wildlife, Dept. of Agriculture, San Juan, Puerto Rico, respectively.

food—mollusks, crustaceans, fishes, sipunculid worms, echinoids, etc.—were separated, their percentage by volume estimated, and the mollusks species determined whenever possible.

Observations. The food habits of this group of fish are presented in Figure 1. They follow the same general pattern illustrated during an earlier study of the biology of the bonefish (Erdman 1960). Clams and snails made up over half of the bonefish's diet. The mollusks found were mostly shell pieces and small fragments. This fragmentation probably resulted from the crushing action of the strong pharyngeal teeth of the bonefish during feeding. A majority of the pieces could be identified, however, but in some cases positive identification to species was not possible.

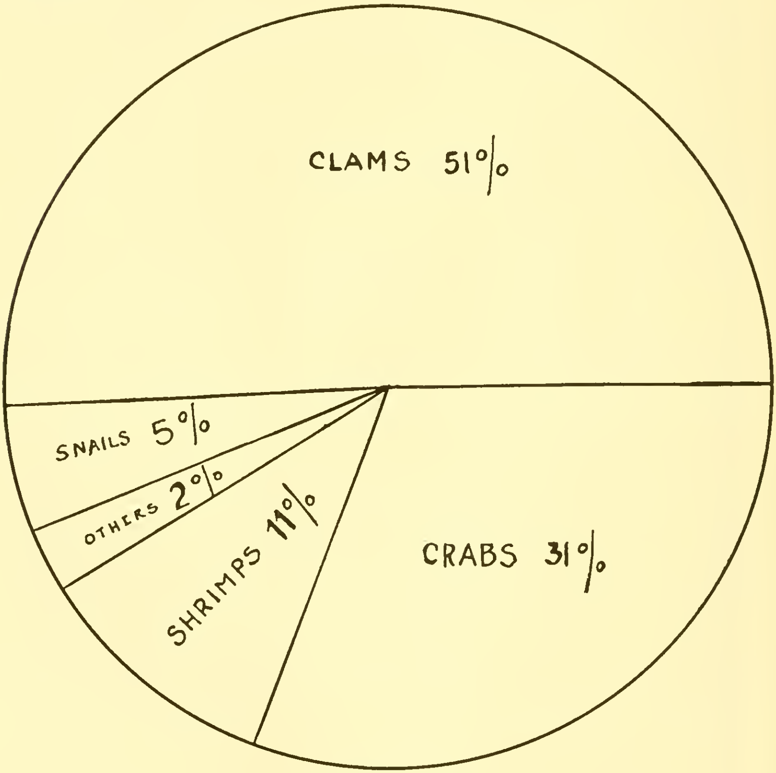


Figure 1. Volumes of food items found in stomach of 272 bonefish expressed in % (modified after Erdman, 1960)

Table 1. Relative importance of mollusk species in diet of 56 bonefish (Albula vulpes L.)

Mollusk species	Fish containing mollusks	
	Number	Percent
Pelecypods		
Codakia costata Orbigny	35	62.5
Tellina caribaea Orbigny	23	41.0
Solemya occidentalis Deshayes	11	19.6
Tellina alternata Say (young)	5	8.9
Ervilia nitens Montagu	4	7.1
Gouldia cerina C. B. Adams	4	7.1
Yoldia perprotracta Dall	4	7.1
Trigonicardia antillarum Orb.	3	5.4
Anadara notabilis Röding	2	3.6
Cardiomya perrostrata Dall	2	3.6
Corbula caribaea Orbigny	2	3.6
Cyathodonta semirugosa Reeve	2	3.6
Divaricella quadrisulcata Orb.	2	3.6
Lucina multilineata Toumey & Holmes	2	3.6
Notocorbula operculata Philippi	2	3.6
Nuculana acuta Conrad	2	3.6
Aequipecten mucosus Wood	1	1.8
Arcopagia fausta Pulteney	1	1.8
Chione pygmaea Lamarck	1	1.8
Lima pellucida C. B. Adams	1	1.8
Macrocalista maculata Linné	1	1.8
Semele purpurascens Gmelin	1	1.8
Trachycardium muricatum Linné	1	1.8
Trachycardium isocardia Linné	1	1.8
Gastropods		
Turbo castanea Gmelin	10	17.9
Tegula fasciata Born	4	7.1
Rissoina cancellata Philippi	2	3.6
Bittium varium Pfeiffer	1	1.8
Bulla striata Brugière	1	1.8
Bullata ovuliformis Orbigny	1	1.8
Caecum pulchellum Stimpson	1	1.8
Cittarium pica Linné	1	1.8
Columbella mercatoria Linné	1	1.8
Crepidula plana Say	1	1.8
Modulus modulus Linné	1	1.8
Smaragdia viridis viridemaris Maury	1	1.8
Tricolia thalassicola Robertson	1	1.8

From one to nine different species of mollusks were found in the digestive tracts of single individuals. Two to four species were most often encountered; sixty-four percent of the fish examined (38 of the 56) had eaten two to four different species of mollusks at the time of examination (Figure 2).

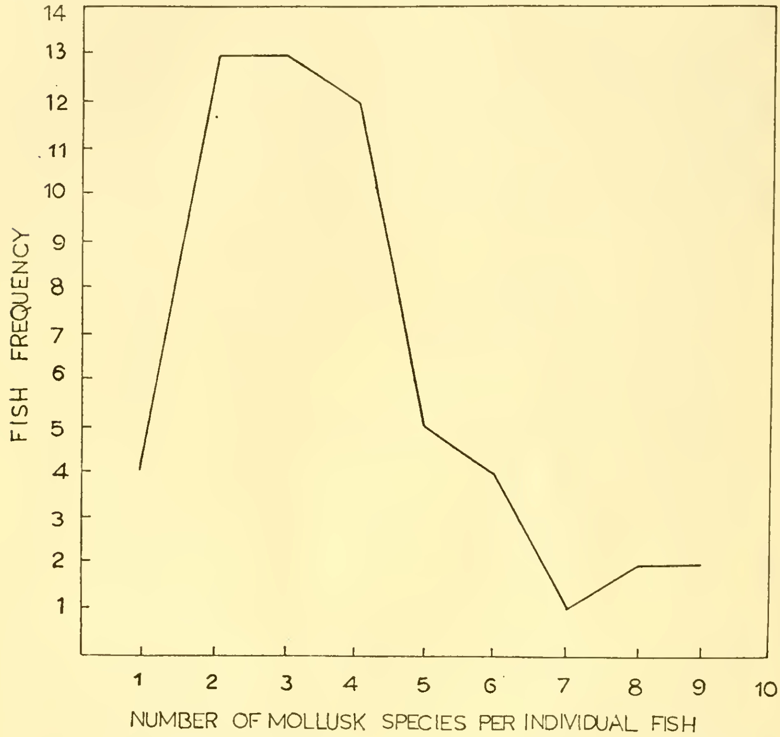


Figure 2. Graphic representation of number of bonefish (from sample of 56 studied) containing one or more different species of mollusks.

Mollusk species eaten by the bonefish, and their relative abundance, are listed in Table 1. The pelecypod, *Codakia costata* Orbigny, was the favored mollusk. This is a small white clam, about ½ inch in diameter. It occurred in 35 fish, or in 62%, of the individuals examined. Next in importance was the pelecypod, *Tellina caribaea* Orbigny, a fragile little clam about 1 inch in length. *Solemya occidentalis* Deshayes, a fragile ½-inch clam, was the only other pelecypod of importance that could be positively identified. It had been eaten by 11, or 19% of the

fish. The only common gastropod found was *Turbo castanea* Gmelin. This hard, brown snail reaches about 1 inch in length. The characteristic operculum or fragments of the shell were found in 10, or approximately 18% of the fish examined.

In addition to the 37 identified species of mollusks listed in Table 1, there were many other shell fragments found in the digestive tracts of the fish. These could be identified with certainty only to genus. Of the miscellaneous, incompletely identified shells, at least two groups of pelecypods can be reported as important in the diet of the bonefish. These are clams of the genera *Laevicardium* and *Tellina*. Shell fragments belonging to the genus *Laevicardium* were present in 17, or approximately 30% of the fish examined, and 25% had whole valves or fragments of shells of miscellaneous species of the genus *Tellina*. Two fish contained scaphopod fragments. The minute gastropods such as *Rissoina, Caecum, Bittium, Bullata,* and *Tricolia* may not have been eaten alive, but probably were ingested as part of the sand in the sipunculid worms.

It is impossible to determine how many shells of a given species an individual fish eats, because they are usually recovered from the digestive tract in pieces. On one occasion, however, in addition to hundreds of fragments, as many as 16 whole valves of *Codakia costata* were found in a 3-lb. male bonefish. In another case, 18 *Turbo castanea* opercula were found in a single 1¾-lb. fish.

There is some evidence that the type of mollusk ingested is related to the frequency of that species in the immediate environment. Clapp (1911) found that the mollusk species in the digestive tracts of haddock corresponded closely with the molluscan fauna obtained by dredging at that location. During the present study, we also noticed that the fish caught at reefs where there are large sand areas contained mostly pelecypods; whereas the bonefish caught at rocky reefs had eaten gastropods. Within these areas, however, considerable selecting was shown with regard to the species of pelecypods or gastropods eaten. (Table 1).

Collecting mollusks from deep-water fish has been suggested as a method of obtaining interesting or rare mollusk species (Clark, 1955). The bonefish, however, cannot be recommended as a source of rare shells. It is a shallow-water reef fish; and most

of the shells it eats, therefore, are common. Also, as previously mentioned, the majority of these are fragmented during the process of ingestion.

Summary

Clams and snails were found to make up over half of the diet of 56 bonefish caught off Puerto Rico. Thirty-seven different species of mollusks were recovered and identified from the digestive tracts of these fish. From one to nine species of mollusks were found in individual fish; two to four species were most commonly encountered, however. The pelecypod, *Codakia costata,* was the favored mollusk, occurring in 62% of the individuals examined. Other mollusks commonly found in the diet of these fish were *Tellina caribaea, Solemya occidentalis,* and *Turbo castanea.* Miscellaneous shells of unidentified species of the genera *Laevicardium* and *Tellina* also were of importance.

References

Baker, F. C. 1916. N. Y. State College of Forestry, Syracuse University, *16* (21):1-366.

Clapp, W. F. 1912. Naut. *25*:104-106.

Clarke, A. H. 1955. Collecting Mollusks from Fish. "How to Collect Shells" Publication of the American Malacological Union.

Erdman, D. S. 1960. Notes on the Biology of the Bonefish and its sports fishery in Puerto Rico. Presented at the fifth International Game Fish Conference, Miami, Florida.

Hiatt, R. W. and Strasburg, D. W. 1960. Ecological Monographs *30*:65-127.

FOUR NEW OLIVELLA FROM GULF OF CALIFORNIA

By JOHN Q. BURCH[1] and G. BRUCE CAMPBELL[2]

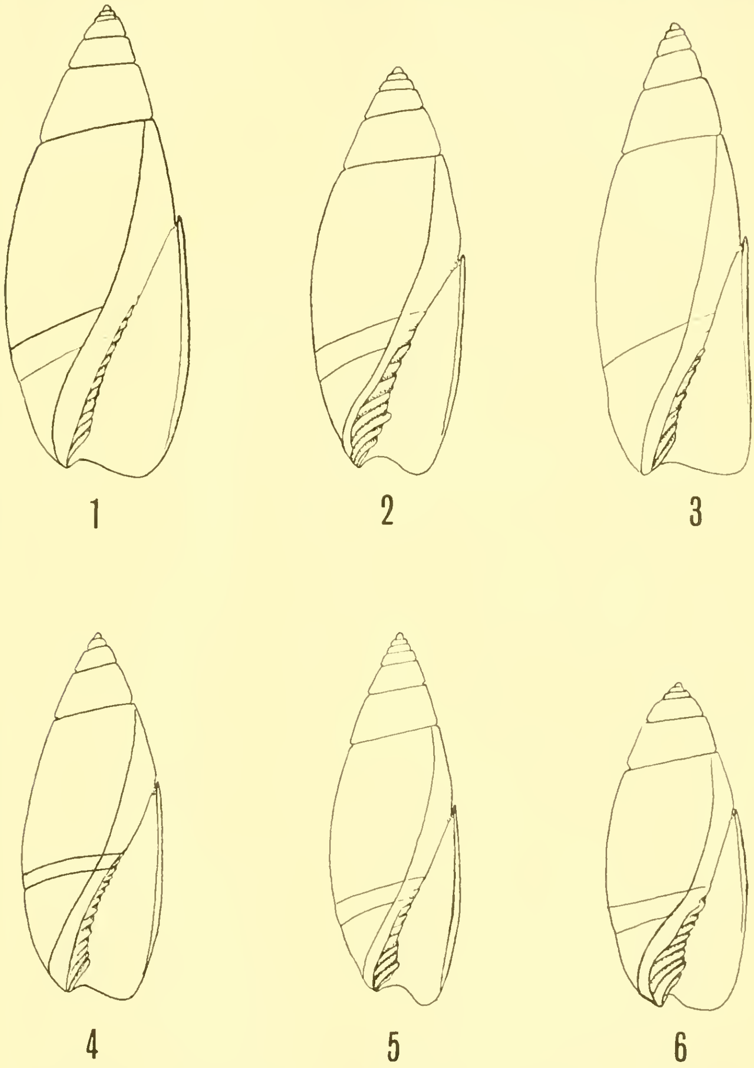
The genus *Olivella* is a well represented group in the Panamic province with 23 or more recognized species. These are allocated to 7 subgenera (Burch) of which the subgenus *Olivella* s.s. is by far the largest with at least a dozen members. We feel that the 3 species and 1 subspecies herein described as new belong to this subgenus.

Olivella s.s. can be identified by the pillar structure which consists of a wide basal portion followed above by a series of

[1] 4206 Halldale Ave., Los Angeles 62, California.

[2] Sea of Cortez Marine Research Center, 10009 California Ave., South Gate, Calif.

short, often paired lirae which may extend to the upper end of the aperture; like most, the parietal callus extends to the suture.



1 2 3

4 5 6

1. *Olivella (Olivella) sphoni* Burch & Campbell, holotype. 2, *O. (O.) steveni campbelli* Burch & Campbell, holotype. 3, *O. (O.) fletcherae* Berry; hypotype, length 12.4 mm., Aguachale, Baja California, Mexico. 4, *O. (O.) riverae* Olsson; paratype, length about 12 mm., Zorritos, Peru, A.N.S.P. 5, *O. (O.) steveni* Burch & Campbell, holotype. 6, *O. (O.) altatae* Burch & Campbell, holotype. (Drawn by Bruce Campbell.)

The radular morphology serves as another means for subgeneric differentiation. That of *Olivella* s.s. has the middle pair of cusps on the rachidian greatly enlarged with 2 or more smaller cusps between them. Olsson (1956) found that this peculiarity was displayed by all the species belonging to this subgenus that he was able to examine. Several attempts to prepare the radulae from our shells were unsuccessful due to the poor condition of the animals. When more material becomes available, radular preparations will be made for study and the typical *Olivella* s.s. structure is anticipated.

Although the main stress is placed on the structure of the shell in this study, the relative importance of shape and color is not ignored. Probably the most important characteristic is the pillar structure. Subgenerically there are wide ranges of variation from a simple fold at the anterior end (*Callianax* H. and A. Adams) to numerous sweeping folds involving practically the whole columella and fasciole (*Lamprodoma* Swainson). In general all the species of *Olivella* s.s. have similar pillar structures. There are variances in the number of folds, the width of folds, their shape, and whether they stand free or join together and arch toward the anterior canal. Certain plications may be more prominent and bound a sulcus which spirals up the columella. The pillar structure as a whole may be narrow and elongate or wide and raised above the parietal callus or it may be shaped in the form of the letter "P" (*O. dama* type of *Olivella* s.s.). No matter how alike the pillar structures might appear there seem to be constant specific differences for each species. These can be of such minimal proportions that it becomes necessary to examine the shell under either a hand lens or microscope. Fortunately other structural differences aid in separation at this point. If there is some doubt as to the subgeneric placement of species with the long narrow pillar structure, then the shell may be rotated to the left to display the concave or deeply excavated condition of the inner columellar wall above the basal fold. This excavation is sharp-edged and the inner ends of the folds or lirae are sharply cut-off, serving for ready recognition of the subgenus *Olivella* s.s.

The habitat preferred by olivellas is sand or sandy-mud, and usually a bar that is exposed by each tide or a flat that is bare

only at minus tides. Others are found only by dredging. The 4 new shells subsequently described represent material that has been collected during the past 4 years. One new species was found mixed in with a large number of *O. fletcherae* Berry that were collected from a small sand bar exposed at a minus tide at Aguachale, Baja California. Another species and the subspecies were dredged from Bocochibampo Bay, Guaymas, Mexico in 20 meters, and this same species was also dredged near Mazatlán, Mexico in 12 meters. The remaining new species was collected intertidally at Altata, Mexico, and the type material was collected and kindly supplied by Eugene Coan. We are indebted to him for his generosity.

OLIVIDAE Swainson, Olivellinae Olsson,
Olivella Swainson, 1831. *Olivella* s.s.

OLIVELLA (OLIVELLA) ALTATAE, **sp. nov.** Plate 6; figs. 5, 6.

Shell small, length about 8.5 mm form subelliptical with an elevated spire of 4½ whorls that is slightly less than one half the length of the shell; protoconch small, white, projecting and dome-shaped; the parietal callus is developed as a thin enamel spread along the inner lip of the aperture and passing above the end of the aperture to the suture; it is semi-transparent so that the markings are not completely obscured; pillar structure of 7 flat widened ridges, the posterior 3 standing free and the remaining 5 arching together around the anterior canal; general color, light brown; below the suture on the body whorl are 2 dark brown bands, the anterior one wider; these are joined at 0.5 mm intervals by narrow vertical brown lines; main portion of the body whorl is covered by irregular zigzag vertical brown or dark gray lines and above the fasciole is checked with brown spots; the rest of the fasciole is white or yellowish white; interior of outer lip is dark brown; no operculum observed.

Holotype: Length 8mm; diameter 3 mm. (Holotype) Calif. Acad. of Sci., Geol. Type Coll. No. 12527.

Paratypes: One each will be placed in collections of John Q. Burch, Bruce Campbell, and Eugene Coan. The remaining 8 paratypes will be distributed to various institutions.

Type Locality: Altata, Sinaloa, Mexico, crawling in the sand at low tide; 21 December 1961. Collector: Eugene Coan.

Of all the existing eastern Pacific species, *Olivella altatae* most resembles *O. broggii* Olsson but may be readily separated from it by examining the pillar structure which is shorter and has fewer folds. In contrast the more numerous folds of *O. broggii* are paired anteriorly. Type locality for *broggii* is Zorritos, Peru,

and Olsson pointed out that it seemed to be limited to northwestern Peru.

OLIVELLA (OLIVELLA) SPHONI, sp. nov. Plate 6; figs. 1-4

Shell medium size, length about 15 mm. relatively thin, spindle shaped with an elevated spire of 5 whorls; body whorl large, subelliptical; protoconch small, light colored, hemispherical; parietal callus is developed as a thin whitish enamel covering the inner aspect of the inner lip up to the suture, partially obscuring the markings; pillar structure of 12 well defined lirations that are short and equal; general color white with patches of gray below the suture; on the body whorl are 2 brown bands, the anterior one wider; these are joined by irregularly spaced vertical lines; main portion of body whorl is covered by numerous brown blotches arranged vertically, the posterior band of the fasciole is white with small brown dots; the remainder is painted with arched patches of brown; interior of outer lip light brown; anterior canal open. Length 13.8 mm; diameter 5 mm. (Holotype)

Holotype: Calif. Acad. Sci. Geol. Type Coll. No. 12528.

Paratypes: A paratype will be placed in the collections of John Q. Burch, Bruce Campbell, and Gale Sphon; others will be deposited in the type collections of several institutions. [S.D.S.N.H. Mus. no. 45219, Corinto, Nicaragua (H. N. Lowe!) S.D.S.N.H. Mus. no. 45221, dredged 20 fms., Acupulco, Mex. (H. N. Lowe!).]

Type locality: Dredged in 20 meters, Bocochibampo Bay, Guaymas, Mexico. Holotype collected June, 1962 by Bruce Campbell and Philip Johnson. One paratype was collected May, 1961 by B. Campbell, Gale Sphon, and Philip Johnson; same locality and depth. Another paratype was collected June, 1959 by B. Campbell; same locality and depth.

Ten additional paratypes were dredged in 12 meters between Dos Hermanos Islands, a few hundred meters off Mazatlán, Mexico by B. Campbell and Vernon Bohr. We are indebted to Mr. E. P. Chace and the San Diego Soc. of Nat. Hist. for the privilege of studying their collection and the loan of material.

There are only two species with which *Olivella sphoni* must be compared. One is *O. fletcherae,* a species that was dredged along with *O. sphoni.* Although they are similar in shape, *O. sphoni* is larger and has twice the number of folds on the pillar structure. A shell with a similar pillar structure is *O. riverae* Olsson. Through the courtesy of Dr. Abbott we were able to examine a paratype of *O. riverae* from Zorritos, Peru. There are major differences in shell shape and color patterns and minor differences in pillar structure. The most northern locality record

for *riverae is* Costa Rica.

It pleases us to honor our good friend Gale Sphon who is in charge of malacology at the Santa Barbara Museum of Natural History.

OLIVELLA (OLIVELLA) STEVENI, sp. nov. Plate 7; figs. 2, 3.

Shell small, length 10 mm, form spindle-shaped with conical spire of 5 whorls which is approximately ½ length of the shell; protoconch small transparent, light, and round; the parietal callus extends along the columella up to the suture, it is semi-transparent and thus partially obscures the markings; pillar structure consists of 8-10 fairly equal plications which are set apart from the parietal callus by a shallow groove; these folds form a rather narrow vertical portion of the columella; general color light to dark gray; just below the suture on the body whorl is a very narrow gray spiral line that is connected to a lighter and wider spiral line by vertical bars; a light band separates this from the main portion of the whorl which is mottled gray with small scattered brown dots; the posterior band of the fasciole is decorated with bars or squares of brown, the remainder of the fasciole is white; the interior of the lip is dark brown; no evidence of an operculum. Length 9 mm; diameter 3 mm. (Holotype)

Holotype: Calif. Acad. of Sci., Geol. Type Coll. No. 12529.

Paratypes: They will be distributed among the type collections of several institutions and the collections of John Q. Burch and Bruce Campbell.

Type Locality. Two miles south of Aguachale, Baja California, Mexico, at a minus tide; 5 May 1962. Collected by B. Campbell and Steven Campbell and Donald Shasky.

Since Aguachale is a local name and not on maps, its location should be described. The turnoff to Aguachale is 26 miles south of San Felipe on the road to Puertecitos. It is then 4 miles to the beach and then 2 miles by four-wheel drive down the beach to the type locality.

This species can be separated easily from the very common *O. fletcherae* among which it is found by obvious differences in color pattern; so far we have seen no intermediate forms. Further differences are seen in the shape of each species and the pillar structures. *Olivella steveni* has more folds on the pillar structure and a row of spots on the fasciolar band. Both are readily differentiated from the much larger *O. gracilis.*

OLIVELLA (OLIVELLA) STEVENI CAMPBELLI, subsp. nov.

Plate 7; figs. 5, 6.

Shell of similar size and form of *O. steveni,* length 10mm; although the body whorl is more obese and the spire shorter; the

shell is white with brown markings in the same pattern as *O. steveni* except the second spiral band of the body whorl is wider and there are condensations of brown above the fasciole; the posterior band of the fasciole is likewise colored with brown blotches and the interior of the outer lip is dark brown; unlike *O. steveni,* the pillar structure consists of 10 plications of which the posterior ones are wider and flat, becoming narrower anteriorly with folds 8 and 9 more prominent. They border a groove which plainly spirals up the columella; the lirate area is raised, thus setting it off from the parietal callus; no operculum present. Length 10 mm; diameter 4 mm. (Holotype)

Holotype: Calif. Acad. of Sci., Geol. Type Coll. No. 12530.

Paratypes: S.D.S.N.H. Mus. no. 45200, dredged 20 fms., Guaymas, Mexico (H. N. Lowe!) and another in B. Campbell collection.

Type Locality: Dredged in 20 meters, Bocochibampo Bay, Guaymas, Mexico in June, 1959. Collector: B. Campbell.

The holotype and paratype of this new subspecies were dredged together with specimens of *Olivella dama, O. fletcherae,* and *O. sphoni.* They remained unidentified until the 6 shells were collected from Aguachale *(O. steveni)* and similarities noted. The color patterns are practically the same and with some minor differences the pillar structures are similar. The shell of the subspecies is somewhat differently shaped. Additional material may tend to increase the separation between the two.

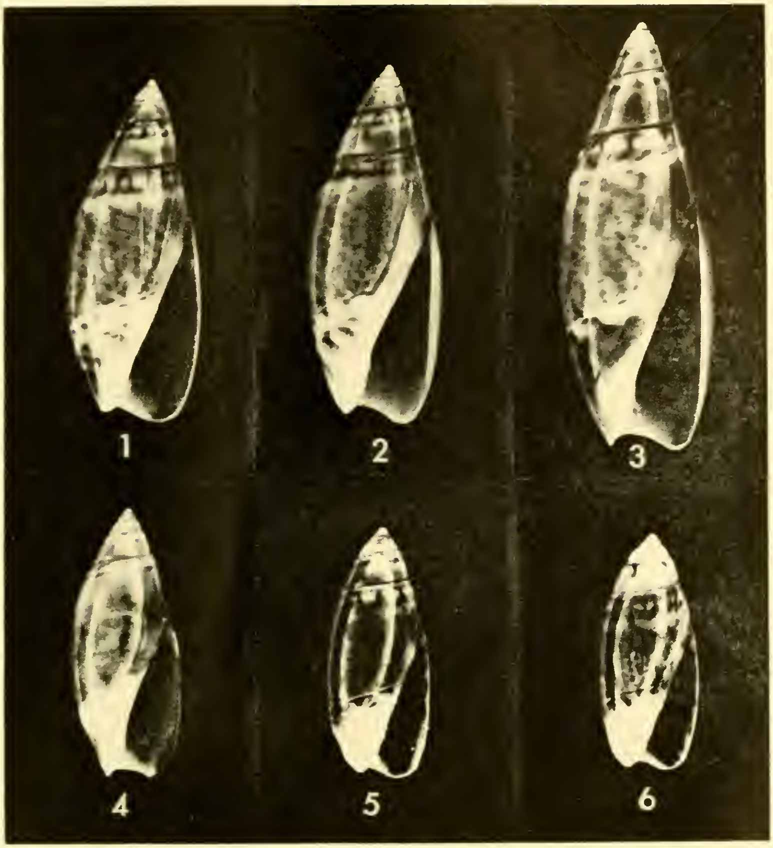
Since the pillar structure does not show up well in a glossy photograph unless the shell is specially coated with magnesium oxide, supplemental line drawings are offered to demonstrate it. The photographs do serve to show the comparative color patterns which are a gross guide for separation. There is a line drawing of the paratype of *O. riverae* which may be compared with *O. sphoni;* also *O. fletcherae* is shown to demonstrate the differences existing between it and *O. steveni.* Likewise in the photographs a picture of an *O. fletcherae* that was collected with *O. steveni* is shown for comparison, as is a picture of an *O fletcherae* taken from the same locality as *O. steveni campbelli* and *O. sphoni.*

References

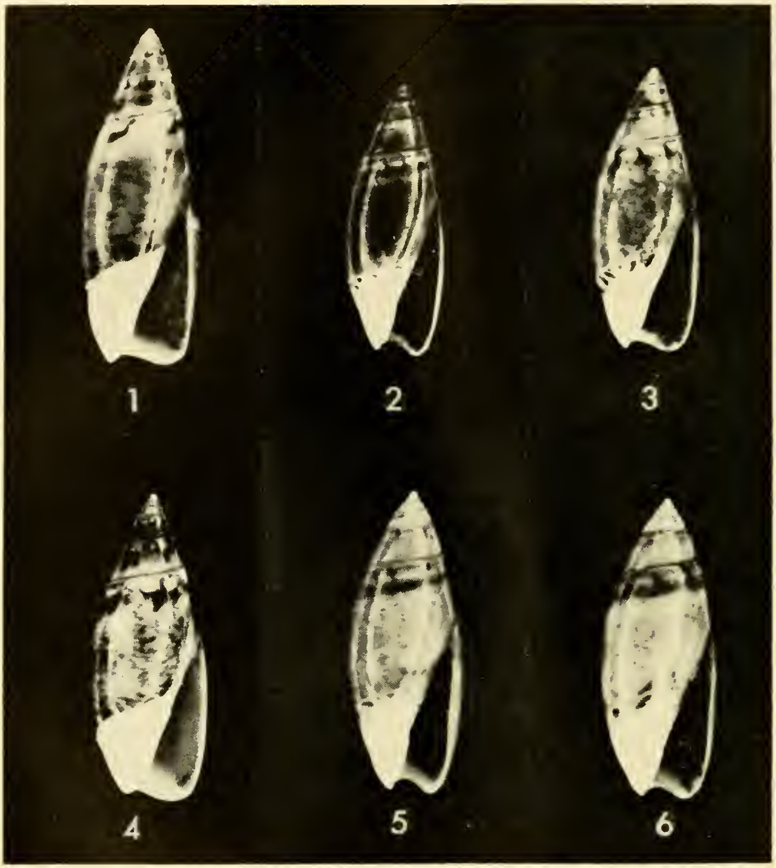
Berry, S. S. 1958. Leaflets in Malac. *1* (15): 85.

Keen, A. M. 1958. Sea Shells of Tropical West America. Stanford University Press, Stanford, Calif. pp. 423-427.

Olsson, A. A. 1956. Proc. Acad. Nat. Sci. Philadelphia, *108:* 155-225, pls. 8-16.



1, *Olivella (Olivella) sphoni* Burch & Campbell, holotype. 2, *O. (O.) sphoni* Burch & Campbell; paratype, length 14.2 mm., Bocochibampo Bay, Guayamas, Mexico 3, *O. (O.) sphoni* B. & C.; paratype, length 15 mm., Dos Hermanos Ids., Mazatlan. 4, *O. (O.) sphoni* B. & C.; paratype, length 9 mm., Dos Hermanos. 5, *O. (O.) altatae* B. & C., paratype, length 8 mm., Altata, Mexico 6, *O. (O.) altatae* B. & C., holotype. (Photographs by Bruce Campbell.)



1, *Olivella (Olivella) fletcherae* Berry; hypotype, length 12.4 mm., Aguachale, Baja California. 2, *O. (O.) steveni* Burch & Campbell, holotype. 3, *O. (O.) steveni* B. & C.; paratype, length 9.5 mm., type locality. 4, *O. (O.) fletcherae* Berry; hypotype, length 12 mm., Bocoshibampo Bay, Guayamas, Mexico. 5, *O. (O.) steveni campbelli* Burch & Campbell, holotype. 6, *O. (O.) steveni campelli* B. & C.; paratype, length 10 mm., type locality. (Photographs by Bruce Campbell.)

LENGTH OF LIFE IN WEST AMERICAN LAND SNAILS

By MUNROE L. WALTON, Glendale, California

The little information concerning the duration of life in mollusks has been reviewed by Comfort, (1957). The life of no North American species of land snail has been adequately documented, and only guesses can be found as to their life span. Studies on longevity should be based on natural as well as laboratory populations, with the preparation of life tables an integral part of the study. In the total absence of any data, however, even fragmentary observations may be of some value.

For the past 12 years, in connection with my activities in collecting land snails, I have, from time to time, caged adult or juvenile specimens and kept records on their growth and length of life in captivity. All specimens were kept in my cellar, a well ventilated, semi-dark room with cement floor. The temperature ranged from 61 to 68 Fahrenheit, with the average about 65. The relative humidity varied between 60-70%. Cages were constructed from heavy corrugated cartons covered with fine-meshed window screening. In each carton, a 7 x 11 inch aluminum tray, filled with a sand and loam mixture, was placed, and kept moistened at all times. The snails were fed on romaine lettuce leaves and bits of of egg shells, with valves of marine clams added occasionally to provide a source of lime.

The snails were checked at least once a week, except when I was absent on collecting trips, and the actual or approximate date of death judged from the condition of the rotting soft parts. Few of the dates cited below could be more than a week or ten days off from the actual date of death. Rest periods occurred at regular intervals, with most snails in aestivation from December to February. If detached from the walls of the cartons, they would usually feed for a few days and then reseal.

For advice on how to present and interpret the data, I am indebted to Alan Solem, Curator of Lower Invertebrates, Chicago Natural History Museum.

The greatest success was in keeping *Ashmunella, Sonorella* and *Monadenia. Oreohelix* refused to eat the lettuce and individuals rarely lasted over a very few months. Two species reproduced successfully although members of the second generation did not reach the size of their parents, undoubtedly because of

deficiences in their limited diet.

The following sixteen records seem worth recording.

Ashmunella kochi ambla Pilsbry. Collected 1½ miles up Pine Springs Canon, Guadalupe Mts., Culberson Co., Texas on March 19, 1952. One (20.5 mm. in diameter) died January 10, 1957; the other (21 mm. in diameter) died August 8, 1958. Two young were first observed in June 1954, and developed the reflected lip of adulthood in October 1956, at 21 mm. in diameter. They were observed in copulation on June 25, 1959 and one young specimen was produced on August 6, 1959. It was 17 mm. in diameter, but not yet adult on April 30, 1962. The 1954 young were observed in copulation again on August 7, 1960, but no additional young have been produced to date.

Ashmunella proxima Pilsbry. Collected at Bull Hill above Bear Springs, northwest end of Chiricahua Mts., Cochise Co., Arizona on April 3, 1955. One 12 mm. adult died June 9, 1957.

Ashmunella townsendi Bartsch. Collected on Hwy. 380, 5.5 mi. west of Lincoln, Lincoln Co., New Mexico on October 19, 1951. Ten adults were caged, with six still living on April 30, 1962. The four deaths were noted on March 10, 1960, June 8, 1960, September 4, 1960 and September 21, 1960. No young were produced.

Sonorella tumamocensis linearis Pilsbry and Ferriss. Collected in Box Canyon on road to Greaterville, Pima Co., Arizona in April 1954. One 16 mm. adult died January 25, 1959.

Sonorella baboquivariensis Pilsbry and Ferriss. Collected on east slope of Brown Canon, Baboquivari Mts., Pima Co., Arizona on May 19, 1951. One adult (19 mm. in diameter) died November 7, 1958; the second (20 mm. in diameter) died January 9, 1959.

Sonorella virilis Pilsbry. Collected at the upper campground, Rucker Canyon, southwestern Chiricahua Mts., Cochise Co., Arizona at 6,000 feet elevation on May 15, 1951. Two young were caged, but neither reached adulthood. One, having grown from 16 to 21 mm. in diameter, died on March 2, 1958; the other, growing from 14 to 19.5 mm., was noticed to be dead on July 1, 1958.

Sonorella grahamensis Pilsbry and Ferriss. Collected in rock slides on Mt. Graham, Graham Mts., Graham Co., Arizona at about 9,000 feet elevation on April 19, 1954. One 16 mm. juvenile

was 20.5 mm. and not adult when found dead on December 11, 1957; the other 15 mm. juvenile was adult at 21 mm. when it died on January 24, 1959. The growth in the cage was quite rough and fibrous compared with the original shell growth. Adult size in the same population was 22 mm., based on adults taken in 1954.

Helminthoglypta ayresiana (Newcomb). Collected on San Miguel Island, California during March 1956. A juvenile 21 mm. in diameter, died sometime during August 1960 as a 25 mm. adult, having reached a larger size than any I have seen previously (maximum diameter, 23 mm.).

Helminthoglypta tularensis sequoia Pilsbry. Collected near Sequoia Lodge, Sequoia National Park, California on September 29, 1956. One 14 mm. juvenile was adult at 22 mm. when it died on September 10, 1959.

Humboldtiana ferrissiana Pilsbry. Collected in a heavy rock slide on Miter Peak, Jeff Davis Co., Texas on October 22, 1952. Of 126 shells taken, only a few juveniles were alive. Two were caged. One, 9 mm. when collected, reached 14 mm. before dying about November 9, 1953; the other, 16 mm. when collected, was a 35 mm. adult when found dead on October 15, 1957. The largest adult taken in the field was only 30 mm. in diameter.

Humboldtiana texana Pilsbry. Collected on Housetop Mountain, 19 mi. east of Marathon, Brewster Co., Texas on May 4, 1953. Found close to the base of bushes on the stems and leaves, or partially buried in soil on an open slope. Two caged adults produced one mass of 22 eggs on October 21, 1953, but none hatched, probably because of excessive moisture in the cages compared with the dry mountain slopes. One adult died July 10, 1955; the other was found dead on September 18, 1955.

Monadenia setosa Talmadge. Collected on Swede Creek, 24.4 mi. east of Willow Creek, Trinity Co., California, on September 28, 1959. A 17 mm. juvenile was 28 mm., and not quite adult, when it died September 20, 1960.

Monadenia fidelis beryllica Chace. Collected four miles north of Gold Beach along U.S. Hwy. 101, Curry Co., Oregon, on September 13, 1954. The two caged adults died January 17, 1959 and about February 19, 1959. Twenty-two young shells were observed in July 1956, of which 5 died in December, without their sizes being recorded. There are three alive on April 30, 1962,

adult at 25 (1) and 29 (2) mm. The others died as follows:

3 slightly before July 12, 1957 at 18, 21 and 21 mm. (juvenile)
2 slightly before July 26, 1957 at 22, 23 mm. (juvenile)
1 on August 12, 1958 at 28 mm. (not quite adult)
2 slightly before November 5, 1958, both 28 mm. adults
1 about January 14, 1959 at 26 mm. (juvenile)
1 about April 2, 1959 at 24 mm. (juvenile)
2 about June 7, 1959 at 30 mm. as adults
1 about February 28, 1960, as a 30 mm. adult
1 May 5, 1961 at 29 mm.

A second batch of eggs produced by the original pair resulted in five young on August 20, 1958. None lived more than ten months, dying about October 21, 1958 (5 mm.), slightly before November 7, 1958 (5 and 6 mm.), about February 7, 1959 (7 mm.) and June 3, 1959 (8 mm.).

Monadenia fidelis klamathica Berry. Collected 5 miles upstream from forks of Salmon River, Siskiyou Co., California on August 27, 1959. Nine adults caged, one still alive. The others all died in 1960—about February 8, March 19, April 7, May 30, June 20, August 15, September 27 and September 30. The remaining shell, now 30 mm. on April 30, 1962, produced 10 young August 1, 1961. At present all are alive, sizes from 8 mm. to 19 mm.

Monadenia churchi Hanna and Smith. Collected 1.3 miles west of Junction City, Trinity Co., California on December 28, 1959. One 8 mm. juvenile reached 11 mm. before death on October 20, 1960; one 13 mm. juvenile is 25 mm. and still alive on April 30, 1962, although not yet adult.

Anguispira kochi occidentalis (von Martens). Collected along U.S. Hwy. 95, 10.7 miles north of Tensed, Benewah Co., Idaho on October 1, 1955. One 25 mm. adult died about September 8, 1959.

Many incomplete accounts are omitted from the above list, and continued records are being kept of the few specimens mentioned above that are still alive.

It is impossible to generalize about a genus from observations on one or two species, or to know that observations on caged specimens will apply to populations in nature, yet a few conclusions can be drawn from the above records.

Ashmunella kochi ambla will become adult in cages in $2\frac{1}{3}$ years and adults can live 5 to over $6\frac{1}{2}$ years, so that a total life span of nearly 9 or more years is possible, conservatively speaking, since adults of *A. townsendi* have lived over ten years. Assuming the same $2\frac{1}{3}$ years from birth to adulthood, the latter

species could live at least 12½ years.

Sonorella may include even more long-lived species, adults of *S. tumamocensis linearis* and *S. baboquivariensis* having survived in cages for nearly 5 and 7½ to 7¾ years, respectively, with a species from a comparably dry habitat, *S. virilis,* having spent seven years in growing from 14 and 16 mm. to 19.5 and 21 mm., respectively, without reaching adult size. In contrast, *S. grahamensis* from a much wetter habitat only took 3½ to 4¾ years to grow from similar size to near adult or adult condition. Probably the species from drier areas will be found to take much longer to grow and be able to remain in aestivation much longer than those from the wetter regions. A 15-20 year life span is not improbable.

A subadult *Helminthoglypta ayresiana* lived nearly four and one half years and reached a larger size than in natural populations, and a 14 mm. juvenile of *H. tularensis sequoia* survived almost exactly 3 years and was adult at death.

Humboldtiana ferrissiana survived 5 years from a 16 mm. juvenile to a 35 mm. adult, reaching larger size than in the natural population, while two adults of *H. texana* survived 2⅓ years in captivity.

Adult *Monadenia fidelis beryllica* lived slightly over 4⅓ years and gave birth to two sets of young. Nine of the 22 in the first lot reached adulthood in 2⅓ to 2¾ years, and four have survived over 5⅓ years. One *Anguispira kochi occidentalis* lived nearly 4 years in captivity as an adult.

Only two successful reproductive cycles were completed. It is undoubtedly significant that the *Monadenia fidelis* from a wet, favorable habitat produced 22 young, only nine of which became adult in about 2½ years, with an adult span of perhaps 3½ to 5 years, while, in contrast, *Ashmunella kochi ambla* from a dry, relatively unfavorable area produced only one or two young, all of which survived, becoming adult in about 2⅓ years but with 4½ to 6½ years adult span. The selective advantages of few young in marginal environments, presumably with low predation, versus many young in wetter areas with presumably high predation are obvious.

References

Comfort, A. 1957. The Duration of Life in Molluscs. Proc. Malac. Soc. London *32* (6), pp. 219-241.

SNAILS FROM TURKEY, CRETE AND GREECE

By THOMAS J. CURTIN[1,2]

Periodic collections of land and fresh water snails were made in Turkey by members of the United States military forces from October 1958 to March 1962. The purpose of the collections was two-fold. Primary emphasis was placed on the evaluation of the fresh water species and the determination of the existence of medically important mollusks. Secondarily, but of great economic significance was the identification of land snails potentially hazardous to American agriculture, that could be introduced into the United States from eastern Mediterranean ports. Attempts were made to collect from major geographical areas and ecological formations throughout Turkey. Intermittent collections were made from Crete and Greece whenever opportunity offered. Thus the specimens from the latter locations are rather limited.

Approximately 3,500 specimens of 29 species were collected. The majority of these snails were taken in or about United States military installations. Confirmation of the identifications was achieved by the U.S. National Museum, Washington, D. C. Specimens of all species except 5 (marked with *), have been deposited with this museum and duplicates of all species, are now in the permanent reference collection of the Fourth Epidemiological Flight, U.S. Air Force, Izmir.

Attention is drawn to the collections of *Theba pisana*, (the white garden snail), from Antalya and western Turkey in 1958 and 1959. Although listed by Abbott (1950) and Burch (1960) as being from Mediterranean countries particular effort was made to evaluate the distribution of this very important species, throughout Turkey. However no specimens of this species were collected during the period 1960-1962 in spite of numerous field surveys. Nor have I been able to obtain detailed information concerning the collections taken in 1958 and 1959 by unnamed collectors. Such collections are only accompanied by area notations. Although the discovery of *Theba pisana* in, at least, littoral Turkey would not be surprising because of its distribution in other Mediterranean countries, its establishment in this

[1] Entomologist, United States Air Force.

[2] Opinions expressed herein are those of the author and are not to be considered the views of the U. S. Air Force.

country is questioned at the present time. Possibly the collections of 1958-59 were taken at U.S. military ports in Turkey and the specimens may have been imported from some north African location. However research of the records of the regional NATO headquarters (LANDSOUTHEAST) reveals only minimal military port activity in the Antalya area prior to 1958.

This species established itself some 40 years ago in southern California (Abbott 1950) where it has been a pest of the citrus industry. It has not become established in other areas of the United States.

No snails of known medical importance were collected during the surveys, although collections were made in eastern Turkey adjacent to the Syrian border. Bilharziasis (schistosomiasis) is not known to occur in Turkey nor have its snail hosts been collected, although reported to be present throughout the Near East (Shattuck, 1951). However this disease has been reported from nearby Syria, (J.A.M.A., 1951) and Iraq, (Manson, 1954).

Thirteen (marked **) of the listed species have been declared by the United States Department of Agriculture (Burch, 1960) to be of quarantine significance. Specimens of *Helicella itala, Monacha schotti, Helix aperta,* and *Otala vermiculata* have been found actively attached to metallic shipping containers in various locations in Turkey, Crete and Greece. Specimens of *Theba pisana* however were found by agents of the Quarantine Service of the U.S. Department of Agriculture on containers that had been shipped from Derince (near Istanbul) during 1959. However, all attempts by the author to collect this species in the area of Derince and Istanbul have failed. Investigation has revealed that at least part of this infested cargo had originally been shipped from Morocco with temporary storage at Derince before being transported to America.

Listing of species

**Ancylus fluviatilis orientalis* Mousson. Adana, May 1959.

**Bulimus leachii* (Sheppard) Seyhan River, near Adana, 1959.

**Chondrus tournefortianus* (Fér.) Ankara, no date.

***Cochlicella barbara.* (Linnaeus). Turkey, no date.

***Helicella derbentina* (Andrzejowski). Sinop, October 1959. Antalya, 1959. Western Turkey, 1959.

***Helicella itala* (Linnaeus). Haydarpasa (Istanbul) December 1961. Buyukdere (Istanbul), December 1960. Iskenderun,

March 1961. Izmit, December 1960. Iraklion (Crete), December 1960.

**Helicella protea* (Ziegler). Western Turkey. Antalya, 1959.

***Helicella striata* (Müller). Antalya, 1958. Western Turkey, 1959.

***Helicella variabilis* (Draparnaud). Izmit, December 1960.

Helicella vestalis (Parreyss). Bursa, 1958. Sinop, 1959.

***Helix aperta* Born. Pireaus, February 1962; Athens, February 1962.

***Helix aspersa* Müller. Bornova, December 1961. Athens, February 1962. Selcuk, January 1962.

Helix cincta Müller. Eastern Turkey, no date.

***Helix figulina* Parreyss. Adana, June 1959. Antalya, 1959. Bornova, 1959. Iskenderun, March, 1961. Selcuk, January, 1962.

***Helix lucorum* Linnaeus. Antalya, 1958. Bornova, January, 1959. Bornova, December, 1961. Derince, December, 1961.

Lymnaea pereger (Müller). Eastern Turkey, no date.

Melanopsis buccinoidea (Olivier). Adana (Seyhan River) May, 1959. Diyarbakir (Tigris River) March, 1959. Iskenderun, March, 1960.

Melanopsis costata turcica (Mousson). Adana, May, 1959.

Melanopsis variabilis Philippi. Western Turkey, 1958.

***Monacha schotti* (Pfeiffer). Izmir, December, 1960. Buyukdere (Istanbul), December, 1960. Iskenderun, March, 1961. Izmit, December, 1960. Iraklion (Crete), December, 1960. Iskenderun, March, 1960.

***Otala vermiculata* (Müller). Antalya, 1959. Iskenderun, March, 1961. Iraklion, December, 1960. Antalya, 1958, Bornova, January, 1959. Athens, February, 1962. Pireaus, February, 1962.

***Oxychilus cellarius* (Müller). Iskenderun, 1961. Haydarpasa (Istanbul), December, 1961. Karamursel, December, 1961.

Planorbis planorbis (Linnaeus). Adana (Seyhan River), March, 1959.

**Radix lagotis*. Ankara, no date.

**Stagnicola palustris* (Müller). Konya, no date. Seyhan, no date.

***Theba pisana* (Müller). Antalya, 1959. Western Turkey, 1959.

Theodoxus sp. Western Turkey, 1959.

Zebrina eburnea (Pfeiffer). Eastern Turkey, 1958. Antalya, July, 1959. Antalya, 1959.

Zebrina detrita (Müller). Bursa, no date.

References

Abbott, R. T. 1950. Natural History (American Museum of Natural History) *59*, (2): 80-85.

Burch, J. B. 1960. Some Snails and Slugs of Quarantine Sig-

nificance to the United States. U.S. Department of Agriculture, Publication ARS. 82-1. 73 pages.
Jour. Am. Med. Assoc. 1951. Schistosomiasis. Report. Vol. *146.* p. 1149.
Manson's Tropical Disease's. 1954. 14th Edition. Cassell & Company Ltd. London, 1140 pages.
Shattuck, G. C. 1951. Diseases of the Tropics. Appleton-Century-Crofts Inc. New York City. 804 pages.

SOME SUCCINEIDAE, WITH A NEW SPECIES

By LESLIE HUBRICHT

During the spring of 1962, the author visited Lake Concordia, Louisiana, the type locality of *Succinea concordialis* Gould, and Alexandria, Louisiana, the type locality for *Succinea grosvenori* Lea and *Succinea haleana* Lea. Good series of all these species were collected and I found that these species were not what they had been generally considered to be. As a result, it will be necessary to change the status of several specific names. While unfortunately these changes must be made, I hope that a better understanding of the species will result, and that further changes in their status will not be necessary.

SUCCINEA CONCORDIALIS Gould.

Succinea concordialis Gould, 1848, Proc. Boston Soc. Nat. Hist. 3: 38.

Succinea unicolor Tryon, 1866, Amer. Jour. Conc. 2: 230, p. 2 (17) fig. 3.

This species was found in large numbers around Lake Concordia, and Lake St. John, and in Ferriday and Vidalia. Specimens from Lake Concordia are usually larger and more elongate than those from the vicinity of New Orleans, and are of a bright golden color with a reddish tip to the spire.

SUCCINEA GROSVENORI Lea.

Succinea grosvenori Lea, 1864, Proc. Acad. Nat. Sci. Phila. p. 109.

Succinea haleana Lea, 1864, Proc. Acad. Nat. Sci. Phila. p. 109.

Succinea forsheyi Lea, 1864, Proc. Acad. Nat. Sci. Phila. p. 109.

? Succinea mooresiana Lea, 1864, Proc. Acad. Nat. Sci. Phila. p. 109.

Succinea (Desmosuccinea) pseudavara Webb, 1954, Gastropodia 1: 18, figs. 4, 5.

Succinea grosvenori is an extremely variable species. In the vicinity of New Orleans, Louisiana, it is small and thin and

could be readily mistaken for *Catinella vermeta* (Say). Near the Red River at the foot of Monroe St., Alexandria, Louisiana, adults are like Binney's figure, and the young like *Succinea haleana*. Near the Red River at a sand pit, 3.5 miles southeast of Alexandria, the whorls are flattened above. Such shells were described as *Succinea forsheyi* by Lea. Shells with the whorls flattened above have been confused with *Succinea witteri* Shimek.

The name *Succinea grosvenori* has long been used as a catch-call for any *Succinea* too large to be called *avara* and too small to be called *ovalis*, so that most published records of its distribution are meaningless. It is known from Alabama, Mississippi, Louisiana, Texas, Oklahoma, Kansas, and Missouri.

SUCCINEA GREERI Tryon.

Succinea greeri Tryon, 1866, Amer. Jour. Conch. 2: 232, pl. 2 (17), fig. 8.

Succinea grosvenori Lea, Pilsbry, 1948, Land Moll N. Amer. 2: 819, figs. 442h, 444a, 444d. (in part).

During the mating season the distal end of the penis in *Succinea greeri* is inflated but does not form a loop. Later the penis contracts and is withdrawn into the sheath. At this later stage it might be confused with *S. grosvenori* but the penial retractor muscle is much heavier and the penis is unpigmented.

S. greeri is a sun loving species. It is to be found on bare ground in full sun. About Vicksburg it occurs on loess banks with a southern or western exposure. It is known from Alabama, Mississippi, and Louisiana.

SUCCINEA WITTERI Shimek

Succinea witteri Shimek, 1913, Nat. Hist. Bull. State Univ. Iowa 6: 31, pl. 1, figs. I-IV.

Succinea concordialis Gould, Pilsbry, 1948, Land Moll. N. Amer. 2: 833, figs. 482-484. (in part).

Succinea witteri is usually found in sunny situations near water. It is apparently rather common west of the Mississippi River from Texas to Iowa. East of the Mississippi it is sporadic in its occurrence, but occurs as far east as Beaufort Co., North Carolina.

SUCCINEA BAKERI, new species. Plate 8, upper figs.

Shell with a little over 3 whorls, thin but firm, elongate-ovate, sculpture of unevenly spaced growth lines and wrinkles. Spire acute, moderately long, sutures well marked, periphery well rounded. Aperture ovate, occupying about sixty percent of the

length of the shell; outer, basal, and columellar margins well rounded.

Height	Diam.	Ap. H.	Ap. W.	Whorls	
13.3 mm.	6.7 mm.	8.0 mm.	5.3 mm.	3.3	Holotype.
15.3 mm.	7.4 mm.	8.9 mm.	5.1 mm.	3.3	Paratype.
13.1 mm.	7.0 mm.	8.2 mm.	5.5 mm.	3.3	Paratypes.

Type locality.—*Illinois:* St. Clair Co.: loess, Stolle, holotype 116915 and paratypes 116913 Chicago Natural History Museum, other paratypes A2150 collection of the author.

The only species in the loess of the upper Mississippi valley with which *Succinea bakeri* might be confused is *Succinea ovalis pleistocenica* Baker, from which it differs in its smaller size, more slender form, and less impressed sutures.

Succinea bakeri is the species usually called *Succinea grosvenori* in Pleistocene fauna lists of the upper Mississippi valley. It is not *S. grosvenori,* as now understood, nor can it be assigned to any other species which one might logically assume to have lived in the upper Mississippi valley during Pleistocene time. In order to prevent further confusion with other species in the literature it seems best to describe it as a new species. As a loess fossil it ranges as far south as Adams County, Mississippi. It is named in honor of the late Dr. Frank Collins Baker.

SUCCINEA URBANA Hubricht

Succinea urbana Hubricht, 1961, Nautilus 75: 32.

Succinea floridana Pilsbry, Walker, 1928, Terr. Moll. Alabama, p. 168. (in part).

Succinea urbana is a common snail on the Selma Chalk and other calcareous outcrops in southwestern Alabama and adjacent Mississippi. It also occurs as a fossil near Ocala, Florida, in company with *Glyphyalinia floridana* (Morrison). It estivates above ground on the stems of plants with a complete disregard for the sun, much like *Bulimulus alternatus* (Say) in southern Texas.

CATINELLA GELIDA (F. C. Baker)

Succinea grosvenori gelida F. C. Baker, 1927, Nautilus 40: 118.

This species is certainly not related to *Succinea grosvenori* as now understood. Some shells resemble a slender *Catinella vermeta* (Say), and others resemble shells of *Catinella wandae* (Webb) from Grand Teton National Park, Teton Co., Wyoming, and it is possible that the name *gelida* has been applied to more than one species. In view of the impossibility of demonstrating the

relationship to either of the above species by anatomical studies, *Catinella gelida* is here retained as a separate species.

Catinella stretchiana (Bland)

Succinea stretchiana Bland, 1865, Ann. Lyc. Nat. Hist. N. Y., 8: 168, fig. 16.

Specimens of this species, collected by Ted C. Frantz of the Nevada Fish and Game Department, at the type locality, Little Valley Washoe Co., Nevada, were dissected. The penis was found to be very similar to that of *Catinella rehderi* (Pilsbry) ; but the appendix is longer, reaching to the end of the penis or a little beyond. The appendix is much more slender than in *Catinella vermeta* (Say) .

NEW SPECIES OF HYDROBIIDAE

By LESLIE HUBRICHT

Antroselates, new genus (masculine) .

Shell: small, solid, globose-conic, narrowly perforate or rimate; spire short, body whorl large, somewhat inflated; sculpture of numerous spiral epidermal threads.

Operculum: paucispiral, hyaline.

Animal: translucent whitish, blind; verge placed in center of back, simple, long and slender, tapering to a point, oval in cross section.

Radula: central tooth without basal denticles or tongue-shaped projection, dorsal margin not reflected, uniformly arched with about fourteen small cusps of nearly uniform size. Lateral teeth with many small cusps of uniform size.

Type species: *Antroselates spiralis.*

The shell of *Antroselates* resembles that of *Somatogyrus* Gill in shape, but differs in the presence of numerous spiral epidermal threads. The animal differs in being blind and in having a very simple verge which is placed in the center of the back, not behind the right tentacle.

Antroselates spiralis, new species. Plate 8, figs. A, B.

Shell: globose-conic, solid, color whitish, subhyaline; sculpture of growth lines and numerous spiral epidermal threads; whorls 4.5, rapidly increasing in diameter, sutures well impressed, spire broadly conical, a little shorter than the aperture; first whorl coiled in the same plain, forming a flat apex; body whorl very large, somewhat shouldered, periphery flattened; aperture roundly ovate, peristome continuous, appressed to the parietal wall, thickened within; umbilicus rimate.

Operculum: ovate, hyaline, paucispiral, of about 3.5 whorls, sculpture consisting only of fine growth lines; nucleus a little left of center, and about one-third the distance from base to apex.

Animal: translucent whitish, blind; verge placed in center of back, simple, long, slender, tapering to a point, oval in cross section.

Height 5.1 mm., Diam. 3.8 mm., Ap. Ht. 3.0 mm., Ap. Width 2.5 mm., Holotype.

Distribution.—*Indiana:* Crawford Co.: stream in Sibert's Well Cave, Wyandotte. *Kentucky:* Edmonson Co.: Mammoth Cave National Park: Echo River and Roaring River in Mammoth Cave; Echo River Spring, holotype 116916, and paratypes 116915, Chicago Natural History Museum, other paratypes 16905, collection of the author; stream in cave in Cedar Sink; large spring in Cedar Sink, stream in Stillhouse Hollow Cave.

Antroselates spiralis is always found on the undersides of large stones in running water. I never found one under a small stone. I can easily understand why an unpigmented snail should stay on the undersides of stones in the springs, but not why it should retain this habit in the total darkness of caves.

FONTIGENS CRYPTICA, new species. Plate 8, figs. E, F.

Shell: elongate, turreted; color pale corneous, subtranslucent; surface smooth, without visible lines of growth; spire conical, apex appearing truncated; whorls 4.5, well rounded, separated by deep sutures; first whorl coiled in the same plane, forming a flat apex; later whorls regularly increasing in size; aperture ovate, peristome continuous, sharp, not thickened within, appressed to the parietal wall for a short distance; umbilicus small or rimate.

Operculum: ovate, hyaline, sculpture very weak, nucleus a little left of center, and about 2/5 the distance from base to apex; of 3.5 whorls.

Animal: translucent whitish, blind; verge unknown.

Height 1.9 mm., Diam. 1.0 mm., Ap. Ht. 0.8 mm., Ap. Width 0.6 mm., Holotype.

Distribution.—*Indiana:* Clarke Co.: under stones in a small spring, 3 miles west of Bethlehem, holotype 116919 C.N.H.M., paratypes 16469, collection of the author. A U.S. topographic map, Bethlehem, Ind.-Ky quadrangle with the type locality marked upon it has been deposited in the Chicago Natural History Museum.

Fontigens cryptica appears to be most closely related to *F. orolibas* Hubricht, differing in being much more slender, with more rounded whorls and deeper sutures.

FONTIGENS TARTAREA, new species. Plate 8, figs. C, D.

Shell: elongate, turreted; buff colored, opaque to subtranslucent; surface smooth with numerous indistinct lines of growth; spire sub-cylindrical, apex appearing truncated; whorls 4.5, flatly convex, separated by deep sutures; first whorl only slightly convex; last three whorls slowly increasing in size; aperture ovate, peristome continuous, sharp, a little thickened within, appressed to the parietal wall for a short distance; umbilicus small or rimate.

Operculum: ovate, paucispiral of about two whorls, hyaline, sculpture very weak, consisting only of growth lines, which are almost invisible except near the end of growth; nucleus placed near the left side about one-third the distance from base to apex.

Animal: whitish, blind; verge unknown.

Height 1.9 mm., Diam. 1.0 mm., Ap. Ht. 0.75 mm., Ap. Width 0.6 mm., Holotype.

Distribution.—*West Virginia:* Greenbrier Co.: stream in Organ Cave, near Organ Cave P. O., holotype 116917 and paratypes 116918 C.N.H.M., other paratypes A4845, collection of the author.

The shell of *Fontigens tartarea* differs from that of *F. cryptica* in having the first whorl slightly convex rather than flat, and in being more cylindrical.

FOUR NEW SPECIES OF PARAVITREA

BY LESLIE HUBRICHT

The four species of *Paravitrea* described herein differ from all previously described species of the subgenus *Paravitrea* s.s. in their small size. The nearest to them in this regard is *Paravitrea smithi* (Clapp), but the two known specimens of that species have only 4.5 whorls and may be immature. They appear to be more closely related to each other than to any of the larger species.

PARAVITREA BIDENS, new species. Plate 9, fig. A.

Shell small, pale pinkish, subhyaline, shining; spire low, convex, with shallow sutures; whorls 6, slowly increasing, last quarter whorl only slightly expanded in mature shells; periphery somewhat flattened in young shells, becoming rounded when mature; umbilicus deep, well-like, contained about 4.5 times in the diameter of the shell; aperture lunate, a little wider than high, slightly flattened above and on the base, lip thin, simple; sculpture of irregularly spaced radial grooves and growth wrinkles, distinct above but becoming weaker on the sides and below; in young shells there is a single pair of tubercular teeth in the last half

whorl, visible through the base of the shell, as the shell grows a new pair is deposited and the old pair is absorbed so that there is never more than a single fully developed pair; teeth are present in all except fully mature shells. Animal dark gray.

Diam. 3.6 mm. Ht. 1.8 mm. Umb. diam. 0.8 mm. Holotype.

Localities.—*Alabama:* Claiborne Co.: below Dugger Mtn. Fire Tower; ravine, 4 miles northeast of Grantley, holotype 116940 and paratypes 116941 Chicago Natural History Museum, other paratypes 26153, collection of the author.

Paravitrea bidens differs from the other small species in the dark-colored animal. It is unique in that it never has more than one pair of teeth. Other species with paired teeth sometimes have only a single pair but it is not the usual condition.

PARAVITREA BLARINA, new species. Plate 9, fig. B.

Shell small, pale yellowish, subhyaline, shining; spire low, convex, with shallow sutures; whorls 5.5, slowly increasing, last quarter whorl slightly expanded in mature shells; periphery well rounded; umbilicus deep, well-like, contained about 5 times in the diameter of the shell; aperture lunate, about as wide as high, lip thin, simple; sculpture of irregularly spaced radial grooves and growth wrinkles which are distinct above but become obsolete on the base; there are no teeth within the shell at any stage of growth. Animal white.

Diam. 3.9 mm. Ht. 2.2 mm. Umb. diam. 0.8 mm. Holotype.

Localities.—*Virginia:* Lee Co.: near Cudjos Cave. *Tennessee:* Hawkins Co.: near Hope Creek, Rices Mill, 2 miles west of Church Hill. Anderson Co.: wooded hillside, 1.4 miles east of Dossett; wooded hillside, 1.7 miles northeast of Clinton, holotype 116938 and paratypes 116939 C.N.H.M., other paratypes 27896, collection of the author. Knox Co.: ravine 4 miles northwest of Halls Crossroads; wooded hillside, 1 mile south of Halls Crossroads.

Paravitrea blarina is a secretive species, found in the lower layers of leaf mold. At the last locality above, it was found crawling about in shrew burrows under the leaves. It differs from the other small species in the absence of teeth in the shell at any stage of growth. There are none of the larger species with which it might be easily confused. Toothless adults of *Paravitrea conecuhensis* (Clapp) resemble it somewhat but that is a larger shell, usually over 5 mm. in diameter when mature, the umbilicus is smaller, and the animal is dark gray.

PARAVITREA TANTILLA, new species. Plate 9, fig. C.

Shell, small, pale yellowish, subhyaline, shining, spire low, convex, with shallow sutures; whorls 6 to 6.5, slowly increasing,

last quarter whorl not noticeably expanded in mature shells; periphery somewhat flattened, base well rounded; umbilicus deep, well-like, contained about 5 times in the diameter of the shell; aperture lunate, about as wide as high, slightly flattened above and on the base, lip thin, simple; sculpture of irregularly spaced radial grooves and growth wrinkles, distinct above but becoming much weaker below the periphery; within the last whorl there are usually one or more pairs of rather large tubercular teeth. Animal white.

Diam. 3.7 mm. Ht. 2 mm. Umb. diam. 0.7 mm. Holotype.

Localities.—*Kentucky:* Lincoln Co.: hillside, 5 miles south of Stanford. *Tennessee:* Fentress Co.: mountainside, 2 miles west of Jamestown. Hawkins Co.: ravine, 5 miles southwest of Pressmans Home. Grainger Co.: wooded hillside, 1 mile northeast of Tate Springs. Warren Co.: bluff of Caney Fork River, 1 mile northeast of Rock Island, Grundy Co.: Big Mouth Cave Sink, 4 miles northeast of Pelham, holotype 116936 and paratypes 116937 C.N.H.M., other paratypes 17531, collection of the author. *Alabama:* Cherokee Co.: wooded hillside, 1 mile east of Forney; rocky hillside, 1.4 miles northeast of Rock Run. Cleburne Co.: Shoal Creek Bridge Camping Area.

The presence of one or more pairs of large teeth in the adult shell will distinguish *Paravitrea tantilla* from the other small species. In its large tubercular teeth it resembles *Paravitrea pilsbryana* (Clapp), but that species has a larger umbilicus and a larger shell.

Paravitrea metallacta, new species. Plate 9, fig. D

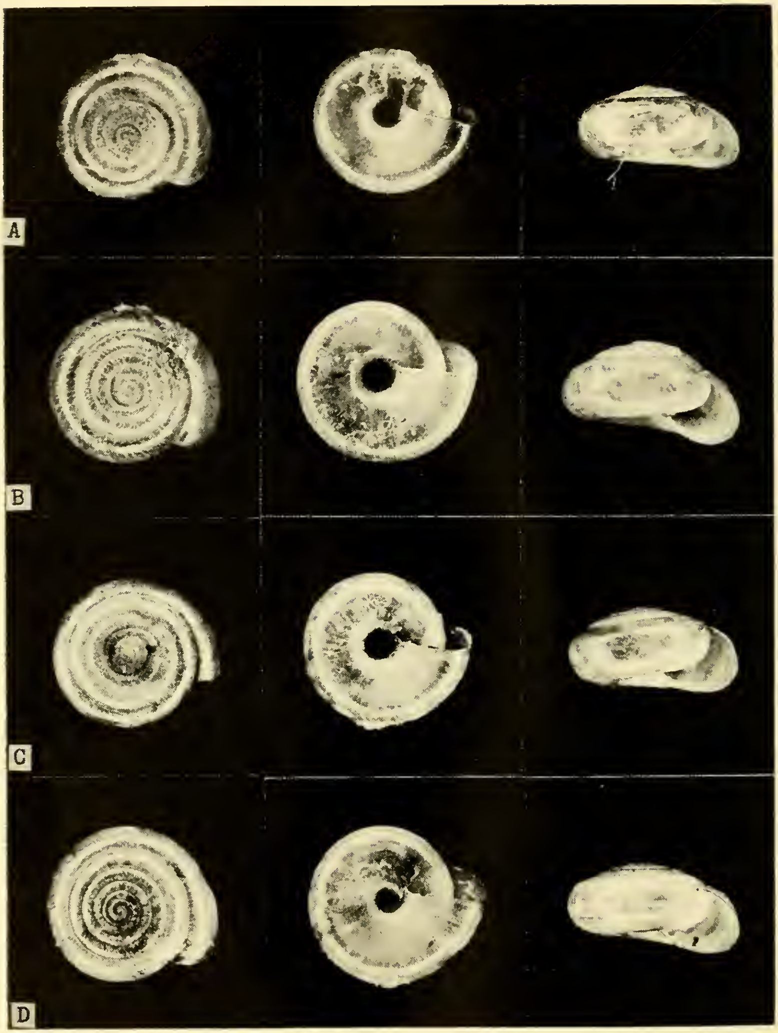
Shell small, pale yellowish subhyaline, shining; spire low, convex, with shallow sutures; whorls 6.5, slowly increasing, last quarter whorl conspicuously expanded in mature shells; periphery somewhat flattened in young shells, becoming rounded when mature; umbilicus deep, well-like, the central hole contained about 10 times in the diameter of the shell, but expanding in the last half whorl to about twice the size of the central hole; aperture lunate, wider than high, slightly flattened on the base, lip thin, simple; sculpture of irregularly spaced radial grooves and growth wrinkles, distinct above and on the sides but becoming weaker on the base; in young shells there are one or two pairs of rather small teeth within the last whorl. Animal white.

Diam. 3.9 mm. Ht. 1.9 mm. Umb. diam. 0.4-0.7 mm. Holotype.

Localities.—*Tennessee:* DeKalb Co.: ravine, 7 miles east of Smithville; Caney Fork River bluff, Sligo Landing; wooded hillside, 10 miles northeast of Smithville, holotype 116934 and paratypes 116935 C.N.H.M., other paratypes 29500, collection of the author.

The small umbilicus and expanded last quarter whorl are the

Upper figs. *Succinea bakeri* Hubricht. A, B. *Austroselates spiralis* Hubricht. C, D. *Fontigens tartarea* Hubricht. E, F. *F. cryptica* Hubricht. All holotypes. (Photographs by Chicago Natural History Museum.)



A, *Paravitrea bidens* Hubricht. B. *Paravitrea blarina* Hubricht. C, *Paravitrea tantilla* Hubricht. D. *Paravitrea metallacta* Hubricht. Holotypes. (Photographs by Chicago Natural History Museum.)

distinguishing characters of *Paravitrea metallacta.* Young might be confused with the young of *Paravitrea capsella* (Gould) but the umbilicus is smaller.

REMARKS ON CASSIS (CASMARIA) VIBEXMEXICANA

By WILLIAM K. EMERSON AND WILLIAM E. OLD, JR.
American Museum of Natural History

In 1893 Stearns recorded two specimens of the Indo-Pacific species, *Cassis* (*Casmaria*) *vibex* (Linné), from west Mexico; one was reported to have been collected by L. Belding from La Paz, Baja California and the other by W. J. Fisher from María Madre Island, Tres Marías Islands. Both were poorly preserved specimens that obviously had been occupied by hermit crabs. A year later, Stearns (1894) referred to these specimens as "*Cassis* (*Casmaria*) *vibex-mexicana* Stearns, Proc. U.S. Nat. Museum, vol. 16, 1893, p. 348." Thus this hyphenated name was made available for the supposed eastern Pacific representative of the *Cassis vibex* complex.[1]

The validity of this species, however, remained doubtful since no additional specimens of the *Cassis vibex* complex were subsequently recorded from the eastern Pacific. Only recently, Keen (1958) suggested that Stearns might have mixed specimens from the Indo-Pacific region with material that he was describing from west America. However, existence of additional specimens of this complex from the tropical eastern Pacific now has been determined.

The presence of a specimen in the collections made by the "Puritan"-American Museum of Natural History Expedition to Western Mexico in 1957 has prompted us to inquire of colleagues whether further specimens were present in collections under their care.

Mr. E. P. Chace (*in litteris,* 1960) informed us that one specimen with definite locality data is contained in the H. W. Lowe Collection of the San Diego Museum of Natural History. This

[1] Actually, under the newly revised international code of zoological nomenclature, compound names are to be united without a hypen and the name is to be treated as if originally published in that form.

specimen, collected at San José Island, Baja California in 1932 (Lowe, 1933), measures 40 mm. in length and 28 mm. in width. The color pattern was reported to be badly faded.

Dr. A. Myra Keen stated (*in litteris,* 1960) that she had recently examined a fresh specimen taken from 20 feet of water at Lobos Island, near La Paz, Baja California by Mrs. Verona McKibbin of Tucson, Arizona. This specimen is large, about 70 mm. in height, and is described by Dr. Keen as follows: "Coloration is in tones of buff and brown, with undulating axial stripes intersected by spiral lines that look to be drawn with a pen. At each intersection of lines and stripes there is a dot of darker color. There are two diffused spots of yellow at the anterior end of the aperture, one on either side of the canal opening, like two golden dots showing through the glaze of the white shell. The interior is a soft violet." An apertural view of this specimen is given by Keen (1960, figure 314) and a dorsal view is presented herein (plate 10, figure 1), through the kindness of Dr. Keen.

Mr. Gale Sphon of the Santa Barbara Museum of Natural History has informed us (*in litteris,* 1962) that four specimens, three adults and one juvenile, were taken at Buena Vista, Palmas Bay, Baja California by Senor Antonio Verdugo, in September, 1961. According to Mr. Sphon, these were not taken alive, but are fresh specimens, three of which were deposited in the Santa Barbara Museum, and one was given to Stanford University.

Dr. Donald R. Shasky of Glendale, California reports (*in litteris,* 1962) the existence of two beach specimens from María Cleofas Island, Tres Marías Islands taken by the late George Willett, in 1938. One of these is in his personal collection, the other is in the collection of Mrs. Helen Du Shane of Altadena, California. According to Dr. Shasky, another specimen was collected on the beach in 1958 near La Paz, Baja California and is in the Du Shane collection.

The specimen taken on the cruise of the "Puritan" at San Juanito Island, Tres Marías Islands is a small, "hermit crab specimen," having well-developed nodules on the body whorl (plate 10, figure 2). During the course of the recent Vermilion Sea Expedition, the senior author found yet another specimen, also a beach specimen, at Santa Catalina Island, in the Gulf of California (plate 10, figure 3).

Two other specimens in the Lowe collection of the San Diego Museum and one in the U. S. National Museum are labeled this species, but lack definite locality data. These specimens are cited from the "Gulf of California, Cooke" and apparently had been received from the late Miss Jeanette M. Cooke, a dealer in shells at San Diego, around the turn of the century. They are badly faded and may not be from the eastern Pacific.

Skin divers and SCUBA divers should make a special effort to locate the habitat of this rare species when collecting in the southern part of the Gulf of California. As it apparently has not been dredged, it is likely to occur in shallow water, and judging from the presently known distribution, it is likely to be a member of the coral reef association.

Synonymy and distributional data follow:

CASSIS (CASMARIA) VIBEXMEXICANA Stearns, 1894. Plate 10, Figures 1-3.

Cassis (*Casmaria*) *vibex* Linné, Stearns, 1893: 348. Not Linné, 1758.

Cassis (*Casmaria*) *vibex-mexicana* Stearns, 1894: 188.

Cassis vibex mexicana [sic] Stearns, Lowe, 1933: 113; Hertlein, 1937, Proc. Amer. Phil. Soc., *78:* 306.

Cassis (*Phalium*) *vibex* (Linnaeus), Keen, 1958: 340. Not Linné, 1758.

Cassis (*Phalium*) *vibex-mexicana* Stearns, Keen, 1960: 340, fig. 314.

Range: Santa Catalina Island, Baja California (San Diego Natural History Museum) to La Paz, Baja California (Keen, 1960) in the Gulf of California, and south to the Tres Marías Islands, Mexico (Stearns, 1894).

LITERATURE CITED

Keen, A. M. 1958. Sea shells of tropical west America. Stanford Univ. Press, 626 pp., illus.

——1960, *Ibid.*, second printing.

Lowe, H. N. 1933. Naut. *46:* 109-115, pl. 9.

Stearns, R. E. C. 1893. Proc. U. S. Natl. Mus., *16:* 341-352, pl. 50.

——1894. *Ibid.*, *17:* 139-204.

NEW FRESH-WATER MOLLUSCA FROM THE EOGENE OF CHILE AND PATAGONIA

BY J. J. PARODIZ, Carnegie Museum, Pittsburgh, Pa.

DIPLODON TRANSANDINUS new species. Pl. 11, figs. 1-4

Shell subelliptical, height corresponding to 62% of the length, rounded in front and narrowed posteriorly. Umbo not prominent,

radially striate, placed at middle of the anterior slope. Dorsal margin straight in its distal part, and forming a 60° angle with the anterior margin. Posterior ridge scarcely noticeable. Concentric lines of growth regularly spaced on the upper part of the shell (about half mm. apart), more conspicuous at the center where they are stronger and waving and interrupted by groove-like depressions giving to the surface a rugose-imbricate aspect similar to the forms of the living *chilensis-granosus* group.

Dimensions: 66 mm. long, 41 high, 10 mm. between valves.

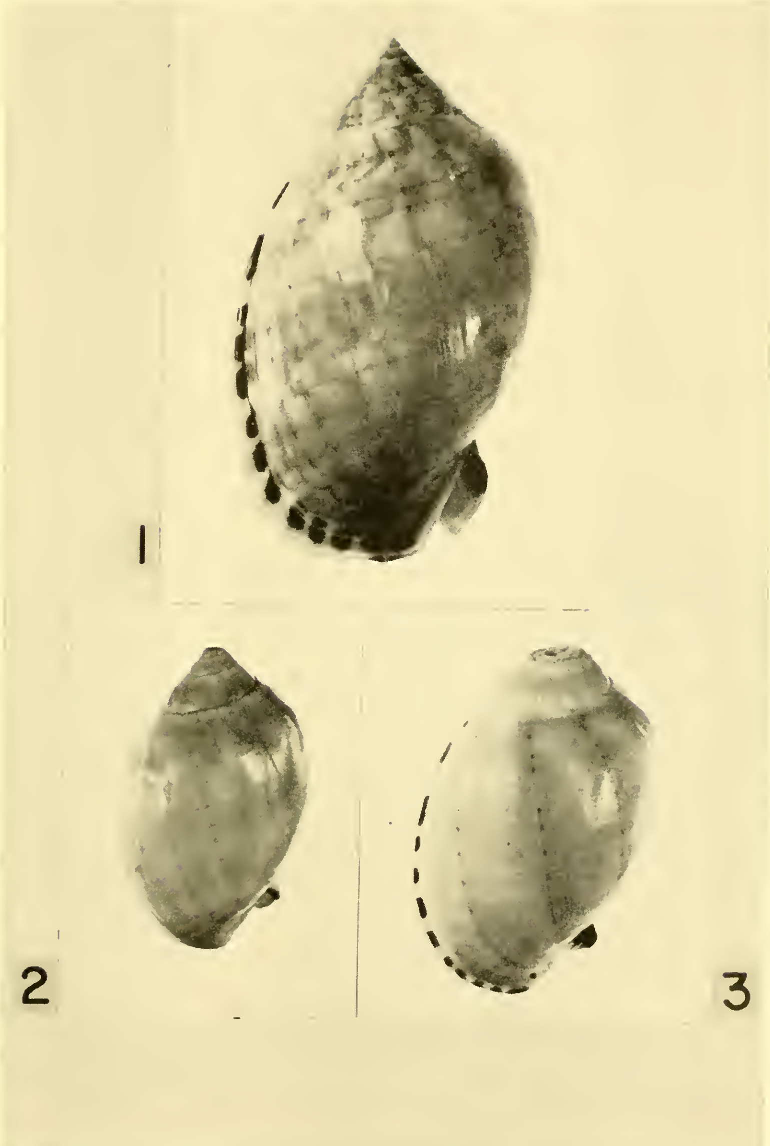
Locality and Strata: A single specimen from Paso Tinguiririca, between the headwaters of the rivers Tinguiririca and Grande, province of Colchagua, Chile, close to the border with the Argentine province of Mendoza, collected by José N. Thomas, 1916. Found in strata representing a northwestern continuation—or synchronical equivalent—, of the Jahuel Formation (Danian); in Patagonia, as well as in Mendoza and Chile, Jahuel underlies the marine Roca Beds (Montian). *Diplodon transandinus* is thus Paleocene.

The fossil has both valves strongly compressed and fractured under the umbo, by diastrophic pressure, resulting very thin in profile; in natural condition the shell probably had a convexity similar to *D. chilensis*. Otherwise is remarkably well preserved. Contrasting with the coal black surface of the valves, the grooves are filled with an oxidized substance (limonite) or rusty color, similar to that known in other species, of the same age, *Diplodon colhuapiensis*.

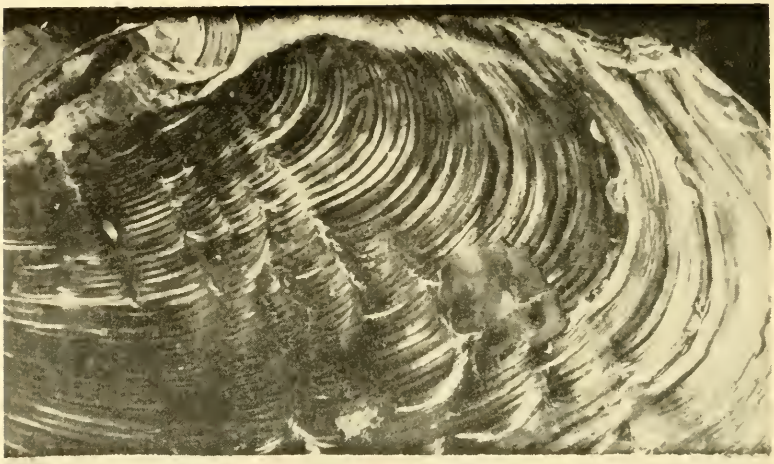
The relationships of this new species with the recent, sympatric, *D. chilensis* are obvious, but the sculpture recalls also *D. granosus multistriatus*. Although these two living species are well separated geographically, they belong to a common stock with parasitic glochidia, *Diplodon* sensu stricto. It also resembles *Hyridella menziesi* from New Zealand, not only in the flatness of the shell, but in outline and surface as well. The affinities of certain South American species with other from Australia and New Zealand was well known but limited to living forms: *D. transandinus* establishes a new link, as old as the early Tertiary.

CHILINA STENOSTYLOPS new species. Pl. 11, figs. 5-6

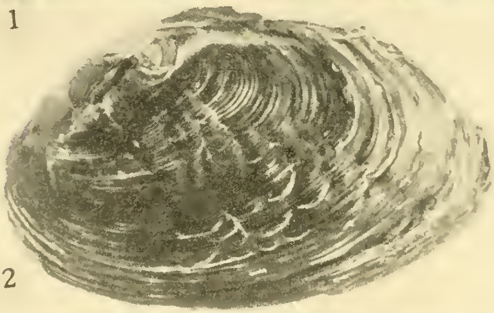
Shell imperforate, lymnaeiform, spire elongate, very acute, occupying about ⅓ of the total length, apical angle 50°. Penultimate whorl as long as half of the spire; body whorl oval elongate, narrower at the base, the wider zone above the middle. 5-6 whorls regularly convex, not gradate. Suture well marked, sutural angle 12°. Aperture twice as high as wide, very angulose



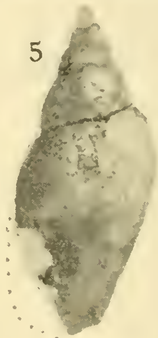
Cassis (Casmaria) vibexmexicana Stearns from west Mexico. Fig. 1. off Lobos Is., near La Paz, McKibbin collection. Fig. 2. San Juanito Is., Tres Marias Is., beach, Amer. Mus. Nat. Hist. collection. Fig. 3. Santa Catalina Is., San Diego Museum collection. Figures approximately x1.



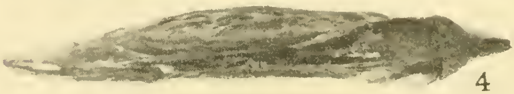
1



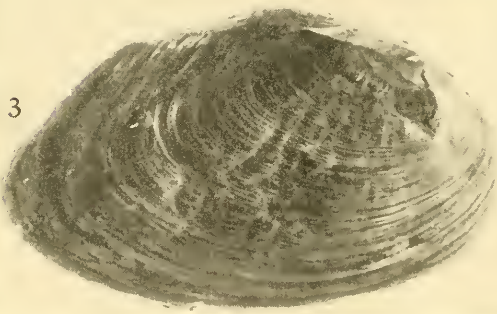
2



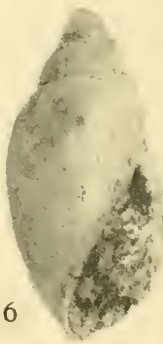
5



4



3



6

Figs. 1 to 4, *Diplodon transandinus* Parodiz: 1, portion of left valve (x 2½); 2 to 4, type, natural size. Figs. 5 (holotype) and 6 (paratype) of *Chilina stenostylops* Parodiz (x 2).

above, expanded but narrowly rounded below; columellar margin with a low, incipient fold, otherwise thin and straight; basal lip on the left side thick.

Dimensions:

	Paratype I (fig.6)	Paratype II only last whorl	Holotype apex broken
Length	23.1		23.5
Width	9.7	9.5	11.7
Last whorl	17.6	11.5	19.0
Penult. w.	2.9		3.1
Spire	6.0		6.5
Aperture		12 x 6	

Locality and Strata: Canadón Vaca, west of Paso Niemann of the Rio Chico, province of Chubut (Patagonia), Argentina. Casamayor Formation (Notostylops Beds), Lower Eocene, Loc. 164 of Scarritt Expedition to Patagonia, collected by G. G. Simpson, 1931.

The calcium carbonate of the shells has been replaced by cristalized infiltrations of silica; the filling of the shells, however, is composed by the characteristic tuffs of Casamayor.

Apparently, this new species is the oldest known *Chilina.* It is close to that group of living forms with *Lymnaea*-like outline and aperture for which Dall (1870) proposed the subgeneric name *Pseudochilina,* and also has a simple columella with folds almost inconspicuous or entirely wanting as in *Acyrogonia* Rochebrune & Mabille, 1889.[1] All these characters are very variable in living species as *aurantia* Marsh., *fulgurata* Pilsbry and *simplex* Marsh, and Pilsbry concluded that they are not valuable enough to keep subgeneric divisions; also Zilch (Gastropoda: 89, 1959) places *Acyrogonia* and *Pseudochilina* as synonyms of *Chilina.* The new species have the general shape of C. *oldroydae* Marshall,[2] but without the strong fold. It may be that the strong and multiple columellar folds are more developed in recent species, and simple, unfolded columella a plesiomorphic character.

[1] The same case is for the living *C. simplex* according to Marshall.

[2] *C. oldroydae* is included within the variations indicated by Pilsbry for *C. fulgurata,* and should be considered synonym.

This is the first fresh-water shell from Casamayor Formation. The few other mollusks known from these strata are all terrestrial:

Strophocheilus chubutiensis Ihering, 1904. Canadón Blanco, Chubut, coll. C. Ameghino 1899.

Strophocheilus hauthali Ihering, 1904. Canadón Blanco, Coll. S. Roth.

Strophocheilus avus Parodiz, 1949. Rio Chico, Chubut, coll. C. Ameghino 1899.

Thaumastus patagonicus Parodiz, 1946. Canadón Hondo, Chubut, coll. G. G. Simpson 1931.

Paleobulimulus eocenicus Parodiz, 1949. Canadón Vaca, Chubut, coll. T. Suero 1948.

Another fossil species of *Chilina* is *C. antiquata* Orbigny (Voyage, Paleont. 1842, p. 141), found with *Diplodon diluvii* Orb., from the cliffs of Rio Negro, of Pliocene age, and closer to the typical gradate recent species.

NOTES AND NEWS

Notes on snail distribution and leech feeding habits in Oklahoma—Following the recent trend of several authors in reporting Oklahoma gastropod records, the following are simply listed, with some exceptions, from the counties where they were secured. Additional information is available in the author's catalog.

Campeloma decisum Say. Delaware, Cherokee, Adair and Sequoyah counties. This mud-burrowing snail forms a continuous series from southwestern Illinois through western Missouri, eastern Kansas and Oklahoma, northeastern Texas, around the southern tip of the Ozarks into and throughout the Austroriparian Biotic Province and into the southern United States.

Cincinnatia integra (Say). Carter, Marshall, Choctaw and McCurtain counties.

Laevapex fusca (C. B. Adams). Bryan County.

Ferrissia shimeki (Pilsbry). Marshall County.

Lymnaea (*Stagnicola*) *bulimoides techella* (*Haldeman*). Alfalfa, Canadian, Carter, Johnston, Marshall and Bryan counties.

Promenetus exacuous (Say). McCurtain County.

Menetus dilatatus (Gould). Marshall, Payne and Cimarron counties.

Gyraulus circumstriatus (Tryon). Major, Caddo, Carter and Marshall counties; probably Pleistocene.

Gyraulus parvus (Say). Carter and Marshall counties.

Helisoma anceps (Menke). Cimarron, Garvin, Carter, Johnston,

Marshall and Woodward Counties.

Helisoma trivolvis (Say). Cimarron, Caddo, Garvin and Marshall counties.

Euconulus chersinus trochulus (Reinhardt). Cimarron, Marshall and Choctaw counties.

Retinella indentata paucilirata (Morelet). Garvin, Carter and Marshall counties.

Mesomphis cupreus (Rafinesque). Wagoner, Adair, Haskell and LeFlore counties.

Paravitrea significans (Bland). Mayes and Adair counties. This species has been rarely collected in Oklahoma.

Pilsbryna tridens Morrison. Major, Custer and Garvin counties.

Hawaiia minuscula (Binney). Major, Custer, Garvin, Carter and Marshall counties.

Ventridens demissus brittsi (Pilsbry). Latimer County.

Zonitoides arboreus (Say). Pawnee, Mayes, Canadian, Oklahoma, Latimer, Choctaw and Cimarron counties.

Striatura meridionalis (Pilsbry and Ferris). Marshall County.

Anguispira alternata (Say). Pontotoc and Marshall counties.

Helicodiscus parallelus (Say). Major, Custer, Canadian, Oklahoma, Garvin, Cartern, Marshall and Mayes counties.

Helicodiscus singleyanus (pilsbry). Garvin and Marshall counties.

Helicodiscus nummus (Vannatta). Marshall County.

Punctum vitreum (Baker). Marshall and Choctaw counties.

Succinea concordialis Gould. Woodward, Greer and Johnston counties.

Catinella vermeta (Say). Carter and Marshall counties. These are dead shells and, although they more closely approximate the morphology of this species than any other, one must dissect the soft anatomy to actually make unreserved succineid identifications.

Vallonia parvula Sterki. Custer, Major, Garvin, Murray and Carter counties.

Vallonia gracilicosta Reinhardt. Major and Greer counties. Probably fossils.

During the summer of 1961, 11 specimens of the leech *Glossiphonia complanata* (Linnaeus) were collected from swamps in McCurtain County, Oklahoma. These specimens, (which ranged from 73.2 to 82.7 mm. in length, were dissected in order to determine the contents of the gut. Four of the specimens were empty; the remaining yielded 24 *Pisidium;* 12 *Cincinnatia integra,* 4 *Gyraulus parvus,* 4 ostracods and 4 chironomid larvae. One specimen contained 4 *Pisidium* which were each 4.0 mm. in diameter.—BRANLEY A. BRANSON, Kansas State College, Pittsburg.

CECINA FROM THE STATE OF WASHINGTON: A new record for North America.—Some small snails found by Dr. J. F. Gates Clarke coincidental to the collection of centipedes on the shore of Chuckanut Bay, Whatcom Co., Washington, represent a new record for North America. These were found under drift in a small embayment on the north shore of the bay, just north of the Great Northern Railroad trestle, on August 12, 1961.

One specimen was an immature *Phytia myosotis* (Draparnaud). In my opinion, this species has been introduced accidentally to every locality in which it is now living in the western hemisphere. At least on the Atlantic coast of the United States, every such locality known to me is either a port, or an oystering wharf. Because of the life history, known to include "crawl away" young instead of a pelagic stage, *Phytia* still shows the same spotty distribution, many years after it first reached those places.

The numerous other shells in this sample resembled a smooth form of *Truncatella*. But there is no *Truncatella* previously known from the coast of Washington, and there is no species of this genus that is completely smooth. The most nearly smooth is the European *T. truncatula,* in its rib-reduced phase. The Chuckanut Bay shells proved to be *Cecina manchurica* A. Adams, 1861 [Ann. Mag. Nat. Hist. (3) *8*:308. (p. 18 of reprint)], originally described from Olga and Vladimir Bays, Manchuria. The discovery of a thriving population of *Cecina manchurica* A. Adams on the coast of Washington adds another genus to the American lists, even if it probably has been an accidental introduction. *Cecina* should be searched for in other places in the region of the Straits of Juan de Fuca. Did this species come over in the days of "Russian America"—or later by ship—or on logging rafts sent down the coast?

Adams, in his original remarks a century ago, said that *Cecina* animals were closest to those of *Truncatella*. The major difference he noted was that *Cecina* had lobate instead of long attenuate tentacles; the other general external anatomy and the method of locomotion were observed to be the same. Specimens recently received from Dr. Habe, collected from Asamushi, Mutsu Bay (northern) Honshu, Japan, have been examined. The tentacles are short but narrow and pointed, as contracted

in the alcohol preservative. In life they must be allowed to rest alongside, applied to the sides of the snout. In this position they appeared lobate to Adams, who apparently did not examine them critically under higher magnification. Also in the original description, Adams said that the apex of the adult shell was eroded, not truncate. The set of shells from Chuckanut Bay prove otherwise. These shells show a progressive loss of the earlier whorls as the shell grows, but this in itself does not prove either erosion or truncation. A few of the newly collected shells from Chuckanut Bay, and at least two of the Japanese specimens show a highly convex wall of truncation or plug, inside thin remnants of the peripheral whorl walls that project along the rim, just as do those of *Truncatella*. As in *Truncatella,* the animal must thin out the peripheral wall of the shell, just above the position in which the new partition or spire plug is to be formed. In the case of *Cecina,* the shell is thinned nearly down to the epidermis, and this remnant disappears rapidly by erosion, and so obscures the truncation process in this member of the family Truncatellidae.—J. P. E. MORRISON.

THE JANTHINID GENUS RECLUZIA IN THE WESTERN ATLANTIC.— In March 1953 Dr. Martin D. Burkenroad collected several dozen live specimens of *Recluzia* which had been washed ashore in company with the brown, floating anemone, *Minyas,* on Mustang Island, near Port Aransas, Texas. Dr. Burkenroad reported in his letter to me that the body of the *Recluzia* is sulphur-yellow and that the long, twisted float, made of brown bubbles, was occupied by brown egg-capsules. The living snail was observed eating the *Minyas,* and its feces were stuffed with the anemone's nematocysts. Until a more thorough study is made of this material, it seems wisest to identify this snail as *Recluzia rollandiana* Petit, 1853. If this species is world-wide in distribution, it would have to take the name of *R. lutea* Bennett, 1840, whose synonyms also include *turrita* Philippi, 1848, *jehennei* Petit, 1853, *montrouzieri* Souverbie, 1872, *erythraea* Jickeli, 1882, and *hargravesi,* Cox, 1870. A "carinate" species, *johnii* Holten, 1803, was described from India.

The Academy of Natural Sciences' collection also contains a specimen of *R. rollandiana* from Sao Paulo, Brazil, which was collected many years ago by H. von Ihering.—R. TUCKER ABBOTT.

NATICA (TECTONATICA) CLAUSA Broderip and Sowerby, 1829, and *Natica (Tectonatica) aleutica* Dall, 1919, are two distinct species. In the paper I read at the meeting of the American Malacological Union in 1956, "Some problems in west coast Naticidae," the conclusion was to place *N. aleutica* as a subspecies of *N. clausa*. Subsequent studies have indicated that this was in error. Both forms occur in the same general locality, with *N. aleutica* being consistently much larger. One specimen measures 60 mm. Mr. Rae Baxter has written from Seldovia, Alaska, that there is a difference in the egg collars, that of *N. aleutica* being smooth whereas that of *N. clausa* has raised spots where the eggs occur.

The conclusion remains to accept *Tectonatica Sacco,* 1890, with type (by monotypy) *Natica tectula* Bonelli, and to place *Cryptonatica* Dall 1892 with type (by subsequent designation of Dall, 1909) *Natica clausa* Broderip and Sowerby in the synonymy.—JOHN Q. BURCH.

NOTOGILLIA WETHERBYI (Dall) in Alabama—This species was found abundant in a large spring at Blue Springs, Barbour County, Alabama. It has not been reported previously from Alabama.—LESLIE HUBRICHT.

NEW LOCALITIES for *Bradybaena similaris* (Fer.) —This species has been found in Montgomery, Montgomery County, Alabama; in Taylorsville, Smith County, Mississippi; and in Alexandria, Rapides Parish, Louisiana. This species will probably spread rapidly through the Gulf States. In a few years it probably will be found in most southern cities.—LESLIE HUBRICHT.

TRIODOPSIS HOPETONENSIS (Shuttleworth) in the Gulf States.—*Triodopsis hopetonensis* has been widely introduced in the South. The author has found it at the following localities: *Georgia:* Atlanta. *Tennessee:* Chattanooga, near Clinton, Etawah, near Martin Springs, North Chattanooga. *Alabama:* Birmingham, Brundidge, Childersburg, Clanton, Dothan, Foley, Gadsden, Gastonburg, Livingston, Marion, Montgomery, Ozark, Pennington, Phenix City, Troy, Tuscaloosa, Uniontown, near Wetumpka. *Mississippi:* Bay Springs, Belzoni, Bonita, Estahatchie, Hattiesburg, Hurley, Jackson, Laurel, Louisville, Marion, Meridian, Quitman, Taylorsville, Waynesboro. A sinistrial specimen was collected in Birmingham, Alabama.—LESLIE HUBRICHT.